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FOREST RESOURCES OF THE MOUNTAIN REGION OF NORTH CAROLINA

by

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A FOREST SURVEY PROGRESS REPORT

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U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE

Appalachian Forest Experiment Station
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Asheville, N. C.

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PREFACE

Through the McSweeny-McNary Act of 1928, Congress authorized the Secretary of Agriculture to conduct a comprehensive survey of the forest resources of the United States. The Forest Survey was organized by the Forest Service to carry out the provisions of the Act, and each of the 12 Regional Experiment Stations is responsible for the work in its territory. In the Middle Atlantic States the Forest Survey is an activity of the Appalachian Forest Experiment Station, Asheville, North Carolina.

The work of the Survey is divided into 5 major phases:

1. Inventory. Determination of the extent, location, and condition of forest lands, and the quantity, species, and quality of the timber on these lands.

2. Growth. Determination of the current rate of timber growth.

3. Drain. Determination of the amount of industrial and domestic wood use, and the total loss from fire, insects, disease, suppression, and other causes.

4. Requirements. Determination of the current and probable future requirements for forest products, by all classes of consumers.

5. Policies and plans. Analysis of the relation of these findings to one another and to other economic factors as a basis for public and private policies and plans of forest land use and management.

This progress report presents preliminary information on the first three of these phases for the Mountain Region of North Carolina, the last of the four units into which the state was divided. A similar release has been published for each of the Coastal Plain Units and for the Piedmont Region.

Information on the physical forest resources was obtained by a field survey made in the summer of 1938. A total of 6,614 sample plots was established at intervals of one-eighth of a mile on compass lines 10 miles apart, extending across the unit in a northwest direction. The statistical sample obtained from these plot records forms the basis for all area and volume estimates in this report, except where other sources are directly credited. Owing to the method of sampling, small tabular items have the greater probability of error and should be considered as indicating relative magnitude rather than actual values.

Data on consumption of forest products for industrial and domestic purposes were obtained by canvassing all primary manufacturing plants and a number of representative domestic consumers.

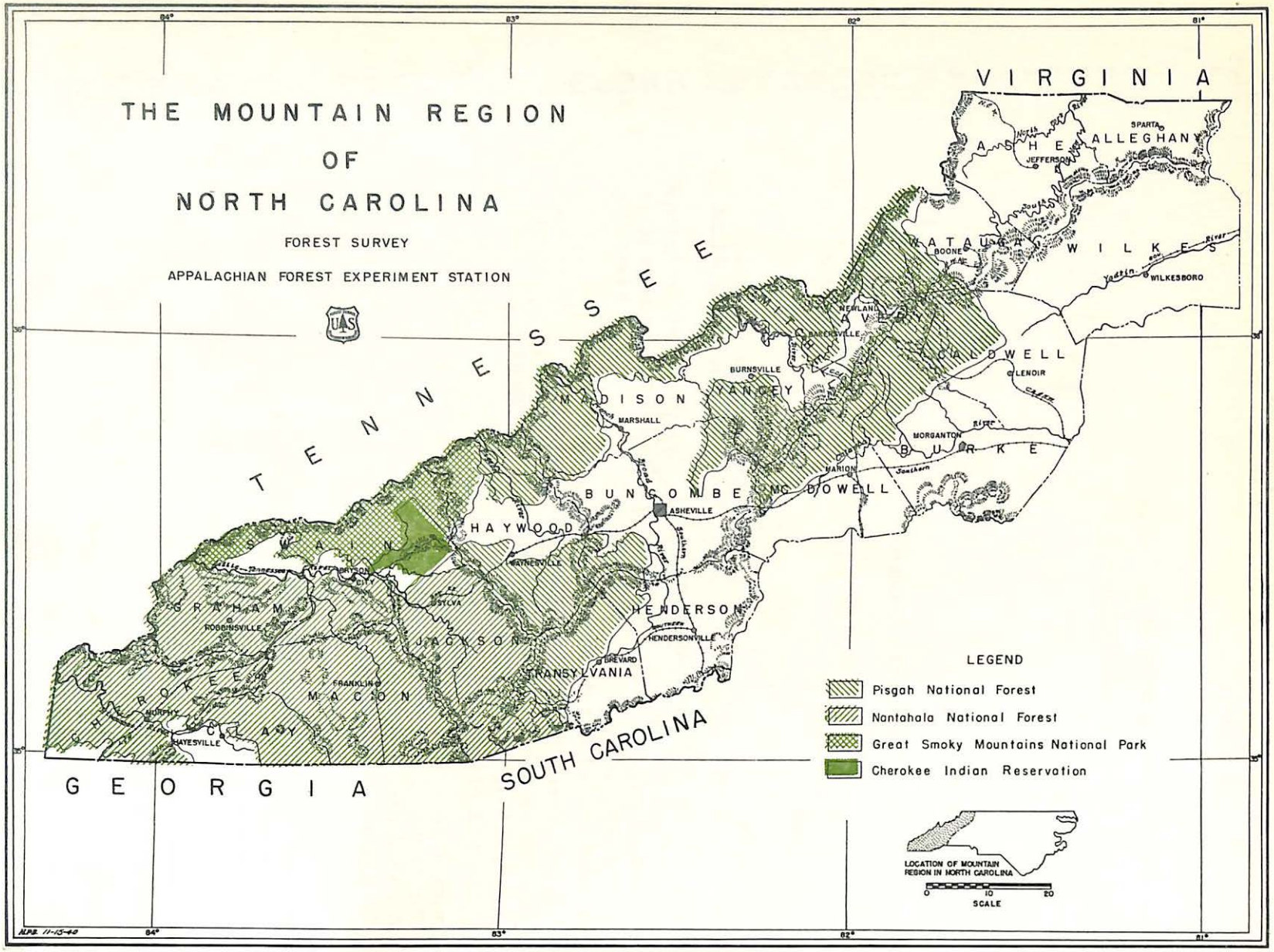
THE MOUNTAIN REGION
OF
NORTH CAROLINA
FOREST SURVEY
APPALACHIAN FOREST EXPERIMENT STATION
VIRGINIA
TENNESSEE
GEORGIA
SOUTH CAROLINA
ASHE
ALLEGHANY
WATAUGA
WILKES
CALDWELL
BURKE
MADISON
YANCEY
MITCHELL
AVERY
BUNCOMBE
MC DOWELL
HAYWOOD
SWAIN
GRAHAM
JACKSON
HENDERSON
TRANSYLVANIA
MACON
CLAY
CHEROKEE
MURPHY
ASHEVILLE
WAYNESVILLE
BRYSON CITY
SYLVA
ROBBINSVILLE
FRANKLIN
HENDERSONVILLE
BREVARD
HAYESVILLE
BOONE
SPARTA
JEFFERSON
WILKESBORO
LENOIR
MORGANTON
MARION
BURNSVILLE
NEWLAND
BANNERTOWN
MARSHALL
LEGEND
Pisgah National Forest
Nantahala National Forest
Great Smoky Mountains National Park
Cherokee Indian Reservation
LOCATION OF MOUNTAIN REGION IN NORTH CAROLINA
0 10 20
SCALE
84°
83°
82°
81°
35°
NPB. 11-13-40

FIGURE 1

FOREST RESOURCES OF THE MOUNTAIN REGION OF NORTH CAROLINA

INTRODUCTION

Forests constitute one of the most important natural resources of the mountain region of North Carolina. They are essential to the valuable tourist and recreation industry, they aid in the control of streamflow and erosion, they furnish food and shelter to game, and they provide raw material for personal and industrial uses, a function highly important in a region where incomes and opportunities for employment are inadequate to meet the needs of local people.

Effective use of this resource is difficult without up-to-date and comprehensive information regarding the existing forest, its deficiencies, limitations, and possibilities. Such information is presented by means of a brief sketch of the physical, social, and industrial conditions within the area, a detailed description of the forest and forest industries, and an analysis of the forest problems.

PHYSICAL CHARACTERISTICS OF THE UNIT

The mountain region of North Carolina, Forest Survey Unit 4, embraces 21 counties located west of the Piedmont Plateau (figure 1). The total area involved is 5,623,000 acres, nearly one-fifth the area of the State.

Physiographically, the mountains of North Carolina are included in the Blue Ridge division of the Southern Appalachians. In Virginia the Blue Ridge is narrow, but in North Carolina it widens out to form a high plateau, broken by mountain masses and river basins, extending from the Piedmont of North Carolina on the east to Tennessee on the west. The eastern edge is bounded by an irregular chain of mountains known as the Blue Ridge, which extends across the state from northeast to southwest. Viewed from the Piedmont this chain presents a steep and rugged escarpment 2,000 to 3,000 feet high. The plateau is enclosed on the west by the Iron, Great Smoky, and Unaka Mountains, which form the boundary between North Carolina and Tennessee.

Between the eastern and western mountain boundaries there are a number of cross ranges that divide the plateau into smaller plateaus or basins, each having its own drainage system. Among these mountain ranges are the Black Mountains; Mt. Mitchell, one of the peaks of this range, rises to an altitude of 6,684 feet, the highest peak east of the Mississippi River. Other cross ranges are the New Found and Pisgah Mountains, the Balsam Mountains, the Cowee Mountains, and the double chain of the Nantahala and Valley River Mountains.

In western North Carolina the Appalachian Mountains Reach their climax. More than 40 peaks are over 6,000 feet in elevation and more than 80 exceed 5,000 feet. Forests extend to the tops of most of the mountains, although on some of the higher elevations the trees give way to mountain meadows, locally known as "balds".

Between the high mountain ranges are fertile valleys. Along the larger streams the valley bottoms are frequently wide and level, well suited for successful farming, but along the smaller creeks tillable land is often at a premium. Practically all of the streams, both large and small, originate high up on the mountain slopes, usually between two spurs or ridges. These secluded mountain valleys are called "coves" and are much prized because of ther fertility.

Drainage from the mountain region goes to both the Atlantic Ocean and the Gulf of Mexico. The Yadkin, Catawba, and Broad Rivers drain the eastern slopes of the Blue Ridge Mountains while the main body of the region is drained westward by the New, Watauga, Nolichucky, French Broad, Little Tennessee, and Hiwassee Rivers with their numerous tributaries. Many of the mountain streams are important sources of hydro-electric power as well as of municipal water supplies, and watershed protection through the maintenance of a forest cover on the steep slopes is a regional necessity.

A high proportion of the soils are classified in the Porter series which includes some of the best soils of the mountain region. With suitable crop rotations most of the soils on the more level lands are very productive. A large part of the mountain land is too rough and stony for agricultural use but many of the gaps and smooth ridges provide excellent pasturage. Much of the land is also too steep for profitable cultivation, and the control of erosion is an ever-present problem. Practically all of the different soils, except those on the exposed ridge-tops, are suitable for timber production and the limitations imposed upon agriculture by soil and topography have allowed two-thirds of the land to remain under a forest cover.

SOCIAL AND ECONOMIC CONDITIONS

Within this region the population exceeds the developed economic opportunity. The scarcity of tillable land, poor farming methods, and lack of markets have resulted in a very low farm income and forest employment has decreased with the depletion of the timber. A high rate of population increase has further aggravated the situation. At present the people are supported by agriculture, timber utilization, manufacturing, the tourist trade, and scattered mines of only local importance. The need for greater development of these economic foundations is obvious when it is realized that about one person in 6 was on relief in 1933-34.

People

The population of the mountain region has increased from 295,000 in 1900 to 520,000 in 1940. The birth rate is extremely high, about 50 percent greater than for the United States as a whole.1/ Since the resources of the region are not sufficient to support such a rapidly increasing population some of the more progressive individuals emigrate to other sections.

1/U. S. Dept. of Commerce, Bureau of the Census, 1930.

With the advent of the depression in the early 30's many of those who had migrated to outside industrial areas returned to the mountain farms and the farm population increased from 241,000 to 285,000 in the five years between 1930 and 1935.

In 1935 about 138,000 persons were employed in farming, business, and industry. Seventy percent of these were engaged in agriculture, 21 percent in manufacturing, 5 percent in retailing, and 4 percent in miscellaneous activities including wholesale trade and the service industries. Approximately 20 percent of all the people live in urban centers of more than 2,500 inhabitants. Asheville is the largest city of the region but Canton, Hendersonville, Morganton, Lenoir, Mt. Airy, and North Wilkesboro are active industrial or tourist centers. About 80 percent of the total population is rural, two-thirds living on farms and in small villages.

Population density has a direct influence upon land-use practices and size of land holdings, both factors that affect agrarian incomes. The distribution of the rural population in this area is modified primarily by topography. The extremely rough and mountainous country is usually without resident population. The people tend to concentrate in the valleys or on the plateaus because the land is more level and fertile for farming, transportation facilities are better and more accessible, and opportunities for industrial employment are more conveniently available. There has been a marked influx of people into the valley areas dominated by Marion, Asheville, Canton, Waynesville, and Sylva. This is due partly to industrial and agricultural advantages and partly to the development of this portion of the Blue Ridge as a recreational center. Other areas of dense population; for example, those in Ashe, Avery, Mitchell, and Yancey Counties, are less an indication of economic opportunity than of overcrowding on the available arable land.

In Yancey County 70 percent of the farmers live on farms averaging only 19 acres in size. In 1935 the average gross value of crops per farm of all farms in the county was only $200 and only a small part of this crop value was converted into cash income. Obviously it is impossible to maintain a satisfactory standard of living on such small acreages without additional income.

Agriculture

According to the 1935 Census of Agriculture, farms occupied 59 percent of the land in the unit. A total of 55,600 farms contained 3,308,000 acres, half of which were woodland. Most farms in the mountain sections were small, with only a few acres in cultivation, and those with extensive cultivatable acreages were restricted almost entirely to the larger river valleys. Sixty percent of the farms contained less than 50 acres and 83 percent contained less than 100 acres. The average farm consisted of 59 acres, of which 14 were cropland, 12 were open pasture, 3 were in miscellaneous uses, and 30 were woodland. The average value of land and buildings in 1935 was $1,665 per farm compared to the state average of $2,069 and the national average of $4,823. The farms of Graham County had the exceptionally low average value of only $752 while those of Henderson County, valued at $2,671, exceeded the state average. In general, farm values are

low because most of the farms are small, with poor buildings, of steep, mountainous topography, isolated from markets. Transportation facilities have been improved since 1930 but at that time 56 percent of the farms were reached by unimproved dirt roads.

Directly associated with low farm values are low farm incomes. In 1929 the gross farm income per farm inhabitant was less than $100 in one-half of the counties in the unit.2/ Only in Haywood and Allegheny Counties did the gross farm income exceed $150 per capita. Since these values include the produce consumed on the farms it is obvious that the cash income per rural inhabitant was meager even before the depression.

In 1935 the value of farm products was approximately 19.5 million dollars, an average of $350 per farm compared to the state average of about $975 per farm. Cultivated crops had a total value of 12.5 million dollars, with corn accounting for 5 million and tame hay for 1.5 million. Tobacco and Irish potatoes were the important cash crops but the value of these two commodities was only 2.5 million dollars in 1935. Farms in Buncombe, Ashe, Haywood, and Wilkes Counties produced a large proportion of the meat animals which were valued at 6.5 million dollars. Forest products sold on about 15 percent of the farms contributed nearly $600,000 to the farm income in 1934.

Manufacturing

Approximately 28,000 people were occupied in the manufacturing industries in 1935, according to the Bureau of the Census. Textile mills employed about 14,000, furniture plants about 5,000, primary wood-using plants about 7,000, leather factories about 1,000, and mines and mineral plants about 1,000. Altogether they received 23 million dollars in wages and made products valued at about 80 million dollars.

Most of the textile and furniture plants are located in Wilkes, Caldwell, Burke, and McDowell Counties, east of the Blue Ridge Mountains (figure 2). Because of the mountain barrier these plants are more a part of the economic life of the Piedmont than of the true mountain region. West of the Blue Ridge Mountains the major industrial area lies in a narrow belt between Asheville and Waynesville, in Buncombe and Haywood Counties. The rayon mill at Enka, near Asheville, is the largest manufactory in the unit from the standpoint of employment provided and the pulp and paper mill at Canton is nearly as large. These two plants and the blanket factory at Swannanoa, just east of Asheville, provide about one-fifth of the total industrial employment in the unit. Other noteworthy industrial developments include the textile mills in Henderson County which employ about 1,000 people and the new cigarette paper mill near Brevard employing about the same number. Three-fifths of the people in the unit live in the 8 counties in which the industrial plants are concentrated, the remaining two-fifths are distributed throughout 13 counties and are largely dependent upon agriculture, timber, and the tourist trade for an income.

2/U. S. Department of Commerce, Bureau of the Census, 1930.

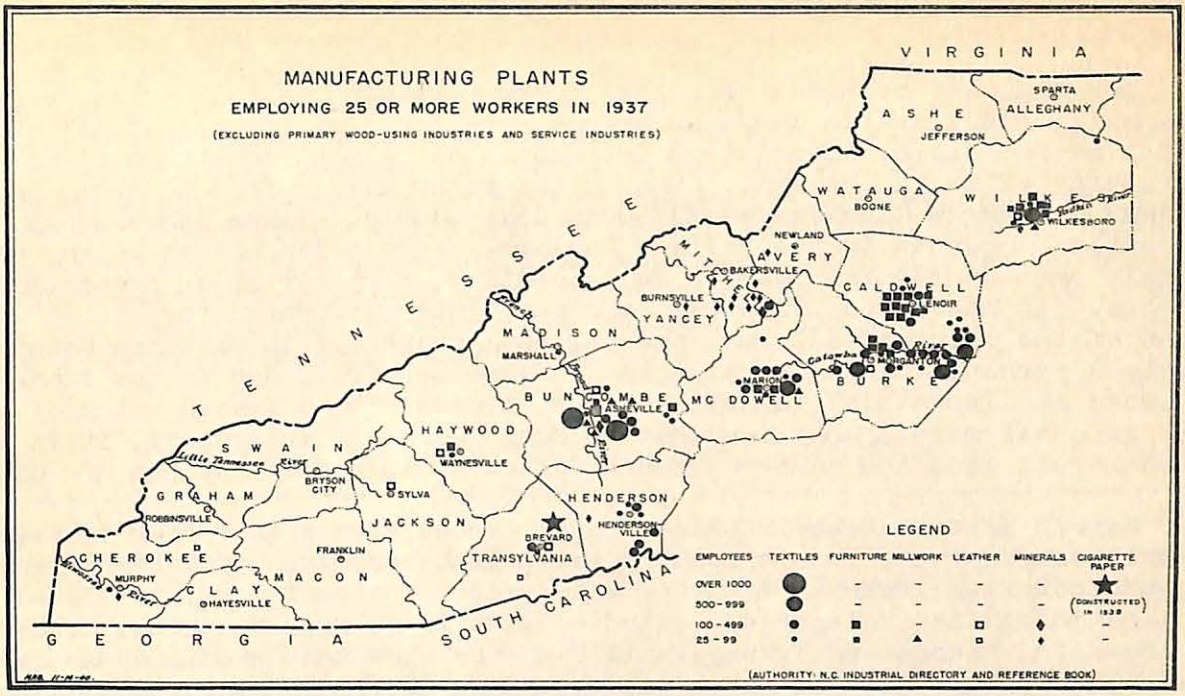

FIGURE 2

Power

The mountain streams of this region have been used for power since the time of the first settlers. Even today water-powered grist mills are a common sight in the rural communities. A few small sawmills are also powered directly by water. These neighborhood industries are relatively unimportant users of the power potentialities of the numerous streams, however, and it was only with the development of hydro-electric plants after 1900 that the electric power became generally available for industrial and domestic use. At present there are about 25 hydro-electric plants with a total capacity of approximately 400,000 horsepower. Five power companies operate hydro-electric stations and distribution systems, and the Aluminum Company of America develops electrical energy at the Cheoah and Santeetlah power dams in Graham County. The largest hydro-electric installation, of 145,000 horsepower, is at Waterville on the Pigeon River in Haywood County. It is owned by the Carolina Power and Light Company and develops the electric energy used in the territory surrounding Asheville. The newest large completed development is the Hiwassee Dam constructed by the Tennessee Valley Authority on the Hiwassee River about 20 miles downstream from Murphy in Cherokee County. Operation for power is scheduled to begin in 1941. The Aluminum Company of America also started construction of the Glenville and Nantahala Dams in the fall of 1940. The power developed at these dams will probably be used in the manufacture of aluminum for national defense.

Taxation

The real and personal property in the mountain region was assessed at 294 million dollars in 1937, an amount equal to 12.5 percent of all such property in the State. Buncombe County contained almost one-third of all the property value in the unit. County tax rates varied from 90 cents in Allegheny and Burke Counties to $2.50 in Clay County. Taxes assessed by the counties amounted to 3.4 million dollars. Forest land makes up an appreciable part of the tax base in some counties, a rather minor proportion in others. In Macon County forest land and timber accounted for nearly 20 percent of the value of all real and personal property; in Buncombe County for only 3 percent. The low ratio in Buncombe County is due to the important urban and industrial values, however, because the assessed value of forest land was more than twice that of Macon County. In general, it is estimated forest land and timber account for about 10 percent of the tax base.

Forest land is usually allocated by tax assessors into four classes for taxation purposes: waste land, cutover land, woodland, and timberland. Among the counties there is a rather wide range of assessed values placed upon land in similar categories. Studies made in 1937 in Buncombe, Caldwell, Haywood, Macon, and Transylvania Counties show that woodland was assessed at $9.76 per acre in Macon County and at $20.42 in Buncombe County. Assessed value of timberland varied from $8.27 in Transylvania County to $29.40 in Buncombe County.3/ Taxes per acre varied from 4.1 to 14.2 cents on waste land, 7.5 to 8.0 cents on cutover land, 12.7 to 19.6 cents on woodland, and 13.4 to 28.2 cents on timberland. The total taxes levied against forest land and timber in the five counties amounted to nearly 30 percent of the rural real estate taxes in those counties.

Land Ownership

Almost one-third of the forest land is in public ownership (table 1). The Nantahala and Pisgah National Forests contain 771,000 acres, including an area of 16,500 acres around Hiwassee Lake recently transferred from the Tennessee Valley Authority to the Forest Service. Much of the more rugged and less accessible land in 15 counties is in National Forests. Most of the Cherokee Indian Reservation is in Swain and Jackson Counties near Cherokee. Other smaller tracts are located in Haywood, Graham, Cherokee, and Macon Counties. The Great Smoky Mountains National Park in North Carolina occupies the eastern slopes of the Great Smoky Mountains in Swain and Haywood Counties. The Blue Ridge Parkway, an elongated park with a scenic motorway, enters the state from the northeast about 20 miles west of Mt. Airy and proceeds southwest along the ridgetops to the Great Smoky Mountains National Park. In most cases the right-of-way is 200 to 300 feet wide although overlooks are wider and parks contain up to 5,400 acres. The State purchased the Mt. Mitchell State Park in Yancey County and it has established the Rendezvous Mountain State Park on privately donated land in Wilkes County. The municipal watersheds belong to cities and towns in Buncombe, Cherokee, Haywood, Jackson, Madison, Swain, and Transylvania Counties. The largest watershed, about 23,000 acres, is owned by the city of Asheville.

3/Nelson, R. W., Taxation of forest property in North Carolina, Forest Taxation Inquiry, U. S. Forest Service, 1938.

By far the largest proportion of the forest land is owned by farmers. As a rule the farm woodlands consist of small tracts, distributed among many of the farms. Most of the industrial owners are lumber companies, although two paper companies own several thousand acres. Investment owners consist of non-operating mining and lumber companies, clubs and associations, recreational development companies, and private owners holding land for speculation. Lumber companies have the largest acreages. Power companies own approximately 100,000 acres around Lake James, Rhodhiss Lake, Waterville Lake, Cheoah Lake, and Lake Santeetlah. The 20,000 acres of hunting preserves are located near Asheville and Lake Toxaway. It is probable that other hunting preserves are included in the 561,400 acres for which no ownership record was obtained.

Table 1. - Ownership of forest land, 1939

Ownership	Distribution of forest area	
	Acres	Percent
Public:		
Nantahala National Forest	331,100	8.6
Pisgah National Forest	439,900	11.5
Cherokee Indian Reservation	53,000	1.4
Great Smoky Mountains National Park	229,800	6.0
Blue Ridge Parkway	21,900	0.6
Mt. Mitchell & Rendezvous Mountain State Parks	1,400	Negl.
Municipal Watersheds	40,200	1.1
Total public	1,117,300	29.2
Private:		
Farm woodlands*	1,670,600	43.7
Industrial owners	200,400	5.2
Investment owners	156,900	4.1
Power companies	100,000	2.6
Hunting preserves	20,000	0.5
All other	561,400	14.7
Total private	2,709,300	70.8
Total all forest land	3,826,600	100.0

*1935 Census of Agriculture.

Land Use

The use of land affects nearly every phase of community life. This is especially true in the mountain region with its large rural population. About two-thirds of the land is forested but not all of this is used primarily for timber production. The wooded mountains of the Great Smoky Mountains National Park are dedicated to recreational use and commercial timber sales are prohibited by law. The Nantahala and Pisgah National Forests combine commercial timber production with recreational use. Much of

the land in these Forests was acquired in a cut-over condition and consequently many years will elapse before full productivity can be restored. In the meantime the recreational assets of the Forests are being developed, with immeasurable benefit to the vacationing public and with concrete financial returns to the adjoining local communities. It is estimated that Buncombe County, in which Asheville is located, obtains 10 million dollars annually from the tourist trade.

The wooded mountain slopes are valuable also for water control and storage. The Pisgah National Forest provides water for six local towns and for the large new plant of the Ecusta Paper Corporation at Brevard. One of the more important factors influencing the location of this plant was the assurance of an adequate supply of pure water. In addition, the Champion Paper and Fibre Company at Canton and the Enka Corporation near Asheville obtain part of their water requirements from watersheds on the Pisgah National Forest. Protective strips of forest land are also maintained by power companies around the large reservoirs.

Most of the privately owned forest land is used primarily for timber production by lumber companies and farm owners. Some private forest land is used for recreation in the form of hunting and fishing clubs, private estates, and summer camps. One of the largest commercial concerns devoted to the recreational use of forest land is the Linville Development Company operating in the Grandfather Mountain section of Avery and Watauga Counties.

Figure 3 shows in a general way the areas in which specific kinds of forest land use are dominant. It should be recognized, however, that there are many local variations within any area and that recreation and water control are important uses of forest land throughout the region.

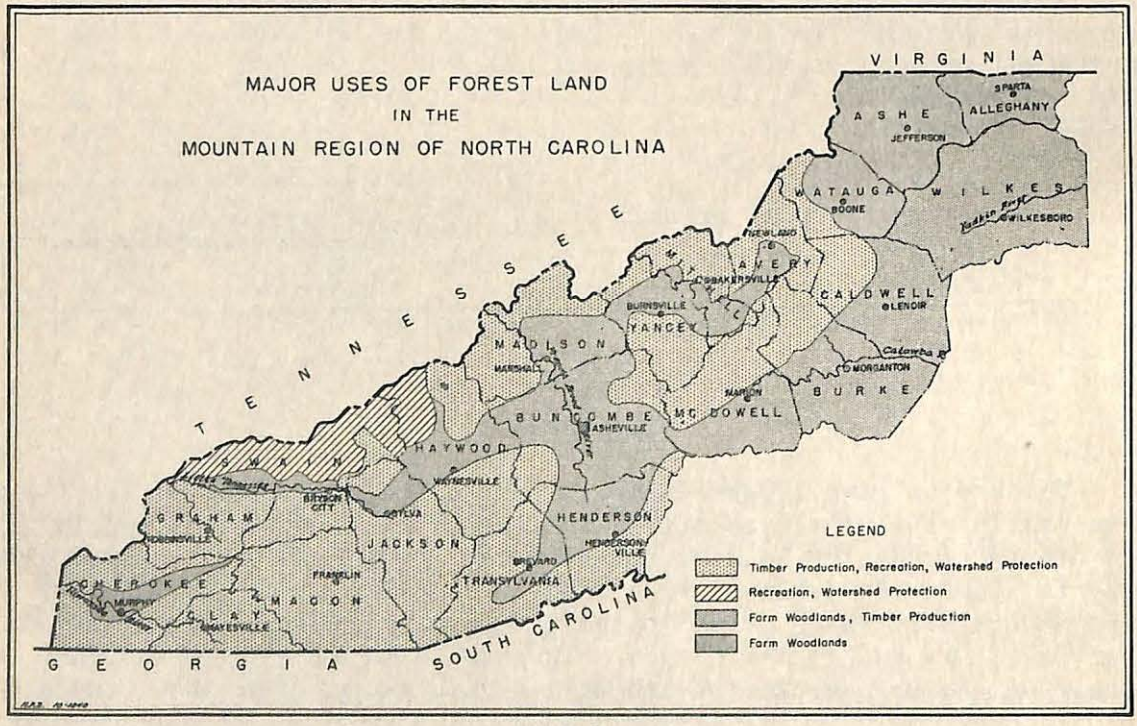

FIGURE 3

Basically, the land in this unit is used for cultivated crops, for grazing, and for forests. A small proportion, 3 percent, is used for townsites and rights-of-way, and an even smaller proportion, 2 percent, is abandoned cropland not in productive use. The non-productive forest land includes rock outcrops and dry ridges too infertile to produce timber of commercial quality. For the unit as a whole, only 17 percent of the land is used for farm crops, 11 percent is in pasture, and 67 percent is forested (table 2). The area within the Great Smoky Mountains National Park has been excluded from this table and will be omitted hereafter in all tables of area and volume, because the land and timber is withdrawn from commercial use.

Table 2. - Total land area classified according to major use, 1938*

Land-use	Area**	Proportion of total area
	Acres	Percent
Forest:		
Productive	3,543,800	65.7
Nonproductive	53,000	1.0
Total forest	3,596,800	66.7
Nonforest:		
Agriculture:		
Old cropland	896,100	16.6
New cropland	25,300	0.5
Pasture	596,100	11.1
Total agriculture	1,517,500	28.2
Abandoned cropland	120,700	2.2
Other nonforest	158,200	2.9
Total nonforest	1,796,400	33.3
Total area	5,393,200	100.0

*Does not include 229,800 acres in Great Smoky Mountains National Park.
**Based on Forest Survey data.

Land use varies considerably between counties (figure 4). Only a small proportion of the land within each county is used for cultivated crops, varying, according to the 1935 Census of Agriculture, from 5 percent in Swain County to 21 percent in Madison and Mitchell Counties. Open pasture land is most common in Ashe and Allegheny Counties where 41 percent of the land is used for grazing. Over half of the land in Swain County and more than 40 percent of that in Macon County is occupied by public forests. A larger proportion of the forest land is under private ownership in Burke, Jackson, McDowell, and Wilkes Counties than in Swain and Macon Counties where most of the forest land is in the Great Smoky Mountains National Park, the Cherokee Indian Reservation, and the Nantahala National Forest.

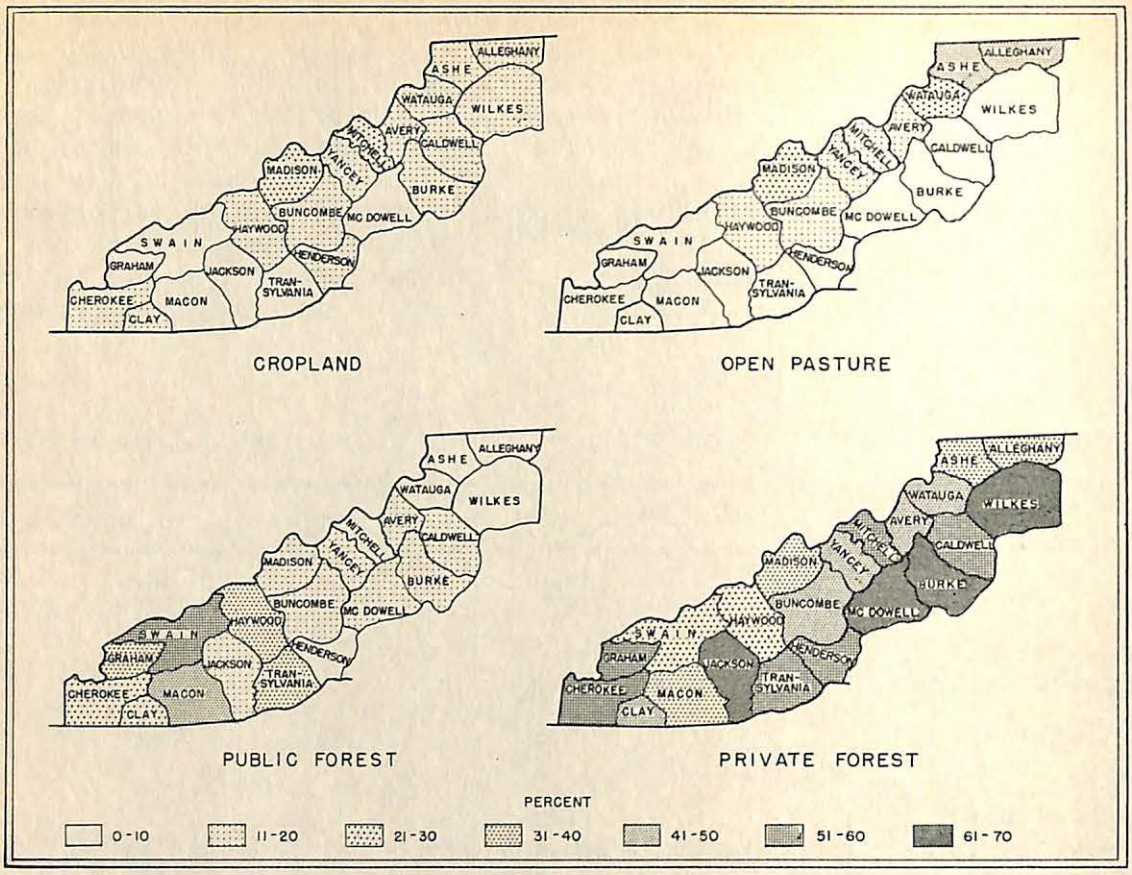

FIGURE 4.- PROPORTION OF COUNTY AREA DEVOTED TO VARIOUS KINDS OF LAND USE.

DESCRIPTION OF THE FOREST RESOURCE

The forests of the mountain region in North Carolina occupy 3.5 million acres, two-thirds of the total land area. A great variety of species are common to this region, Frothingham[4/] lists about 60 that are used commercially. Hardwood species predominate, although eastern white, shortleaf, Virginia, pitch, and table mountain pines, eastern hemlock, red spruce and Fraser fir grow in certain localities. Combinations of species are complex and varied, representing the influence of cutting practices, chestnut blight, forest fires, species peculiarities, moisture conditions, topographic aspect, and elevation. The original mountain forests contained timber of high quality but now only a few scattered stands of old growth remain. Repeated cutting and forest fires have hindered the development of good-quality second growth and at present over one-half of the forest land is stocked with young stands below saw-timber size containing a high proportion of cull trees and low-quality species.

Species

There are at least 50 species of commercial hardwoods. The chestnut blight has killed practically all of the chestnut but even now nearly one-fourth of the sound cubic-foot volume in trees larger than 5.0 inches d.b.h. is standing chestnut still usable for extract wood or lumber. Yellowpoplar is probably the most valuable tree in the region. On moist sites, particularly in the coves, it grows rapidly and produces wood of good quality that is used for lumber, furniture, and veneer. It is abundant, readily salable, and comparatively easy to reproduce and manage.

The white oak growing in the coves is generally of excellent quality but on the drier ridges it is of little value. In coves and on ridges that are not too dry northern red oak produces good saw timber. Chestnut oak is abundant and is the best of the oaks growing on the drier sites. It is used for sawlogs and crossties and the bark is a source of tanning extract. The oaks in the red oak group (black, scarlet, and southern red) are of rather inferior quality although black oak may be a good timber tree on fertile soils. Scarlet oak often is culled because of heart-rot and excessive limbiness.

The hickories, shagbark, mockernut, pignut, and bitternut, are abundant, but as a group they are looked upon with disfavor by lumbermen because of shake and a predominance of red heartwood in the older trees. Young second-growth hickory on a good site makes rapid growth and is used for handles, ski stock, and other special products. Red maple is rather common, growing on practically all sites. It is used in the cheaper grades of furniture and for paper pulp. Basswood, almost as valuable as yellowpoplar, grows with it in the coves. Black locust is found on all sites except at the highest elevations. Sugar maple, black cherry, ash, and black walnut are valuable species but of infrequent occurrence. One of the best stands

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4/Frothingham, E. H., 1931. Timber growing and logging practice in the Southern Appalachian Region. U. S. Dept. Agr. Tech. Bul. 250. 93 p. illus.

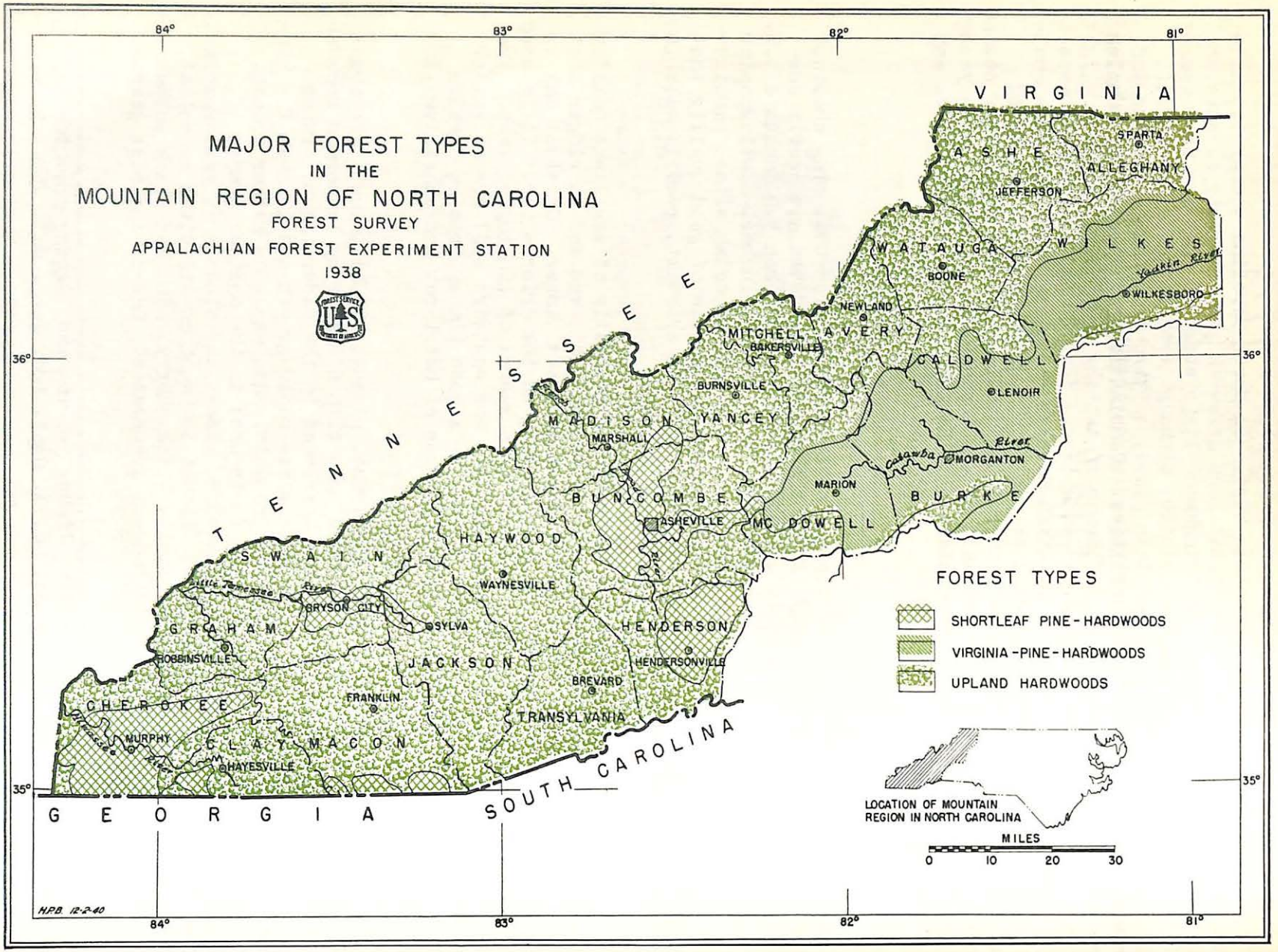
MAJOR FOREST TYPES
IN THE
MOUNTAIN REGION OF NORTH CAROLINA
FOREST SURVEY
APPALACHIAN FOREST EXPERIMENT STATION
1938
VIRGINIA
TENNESSEE
GEORGIA
SOUTH CAROLINA
ASHE
ALLEGHANY
WATAUGA
WILKES
AVERY
MITCHELL
YANCEY
MADISON
CALDWELL
BURKE
BUNCOMBE
MC DOWELL
HAYWOOD
SWAIN
GRAHAM
CHEROKEE
CLAY
MACON
JACKSON
HENDERSON
TRANSYLVANIA
SPARTA
JEFFERSON
BOONE
NEWLAND
BAKERSVILLE
WILKESBORO
LENOIR
MORGANTON
MARION
BURNSVILLE
MARSHALL
ASHEVILLE
WAYNESVILLE
BRYSON CITY
SYLVA
ROBBINSVILLE
MURPHY
HAYESVILLE
FRANKLIN
BREVARD
HENDERSONVILLE
Little Tennessee River
Hiwassee River
Yadkin River
Catawba River
FOREST TYPES
SHORTLEAF PINE - HARDWOODS
VIRGINIA - PINE - HARDWOODS
UPLAND HARDWOODS
LOCATION OF MOUNTAIN REGION IN NORTH CAROLINA
MILES
0 10 20 30
84°
83°
82°
81°
36°
35°
H.P.B. 12-2-40

FIGURE 5

of old-growth sugar maple is along Big Ivey Creek in Buncombe County. Many other hardwood species grow in the mountain region but they have not been discussed because of their scarcity or low commercial value.

Shortleaf pine is the most important softwood species on the lower slopes and plateaus. It is common in the Asheville Basin, in Henderson and Cherokee Counties, and in the foothills of the Blue Ridge Mountains in association with Virginia pine. Pitch and table mountain pine occur on the upper south and west slopes of the mountains. On poor sites they are inferior trees but on good sites pitch pine is often equal in quality to shortleaf pine. Eastern white pine is irregularly distributed throughout the unit but is most abundant in Caldwell and Wilkes Counties. It grows on both the higher slopes and in the valleys, wherever it is not too dry and windy. Eastern hemlock is less abundant than eastern white pine. Although extremely tolerant of shade it prefers moist fertile soil and the cool, humid climate of north slopes and coves. Red spruce is associated with Fraser fir (southern balsam fir) at the highest elevations. Most of the remaining spruce-fir forest is in the Great Smoky Mountains National Park but scattered stands occur in the Pisgah National Forest and the Asheville municipal watershed.

Forest Types

In the field survey the forest stands were classified into 16 forest types but for the purpose of concise presentation they have been combined into five; upland hardwoods, cove hardwoods, shortleaf pine-hardwoods, white pine-hardwoods, and Virginia pine-hardwoods. The relatively small area in the cove hardwoods and white pine-hardwoods types are not shown in figure 5, neither are the areas of included agricultural land.

The upland hardwoods type is most prevalent, occupying 60 percent of the forest land (table 4). It includes the forests growing on the dry slopes and ridges facing south and west and also the forests on the north and east slopes not included in the cove hardwoods type. Nearly two-thirds of the land in the upland hardwoods type contains considerable dead chestnut in mixture with various species of oak. Topographic aspect does not greatly influence the distribution of species but the south and west slopes are least productive. Compared with the cove hardwoods this type contains a smaller proportion of yellowpoplar, basswood, birch, and sugar maple and a larger proportion of red and white oaks, hickory, and dead chestnut (table 3).

The cove hardwoods type occupies less than 10 percent of the forest land. It includes the hardwoods typical of the narrow coves and also the northern hardwoods of the upper moist slopes. Yellowpoplar is the leading live species (table 3) although it usually occurs in mixture with basswood, northern red oak, various hickories, hemlock, birch, black cherry, ash, walnut, buckeye, black locust, and dead chestnut. Abandoned fields in the coves have often restocked to pure stands of yellowpoplar. The northern hardwood variation is the typical beech-birch-maple type of the northeastern states. The usual cove hardwoods type affords the best opportunity for commercial timber growing in the mountains but it is difficult to find large contiguous areas of this productive forest.

Of the pine types, shortleaf pine-hardwoods, established on 17 percent of the forest land, is the most extensive. Stands of table mountain and pitch pine are included with this type although they differ in quality and usually grow at higher elevations and on less productive sites. On two-thirds of the type area the pines are in mixture with hardwoods, the remaining area is largely pine alone. Sixty-five percent of the type volume is composed of shortleaf, table mountain, and pitch pines and an additional 10 percent is Virginia and eastern white pine. Red and white oaks are the chief hardwood associates although dead chestnut and yellowpoplar are common.

Table 3. - Species composition of the forest types, 1938

Species	Upland hardwoods	Cove hardwoods	Shortleaf pine-hardwoods	White pine-hardwoods*	Virginia pine-hardwoods	All types
			Percent of cubic volume**			
Shortleaf pine	1.6	0.1	65.2	2.7	17.0	13.9
Eastern white pine	0.8	0.3	2.9	27.2	3.7	4.4
Virginia pine	0.2	0.1	6.9	1.9	52.8	3.8
Eastern hemlock	0.8	2.7	0.1	22.6	0.1	3.4
Red spruce	--	--	--	8.1	--	1.0
Yellowpoplar	3.6	21.0	2.3	3.6	5.8	5.4
Basswood	0.2	7.7	--	0.9	--	1.1
Sugar maple	0.2	3.4	--	0.6	--	0.6
Ash-cherry-walnut	0.6	3.8	--	0.2	0.5	0.8
White oak	7.2	2.2	3.8	3.8	3.9	5.5
Northern red oak	7.1	6.0	0.3	1.4	0.5	4.8
Chestnut oak	9.8	1.1	1.5	1.9	1.6	6.0
Red oak	12.9	0.8	8.9	5.2	6.7	9.7
Red maple	3.0	2.7	0.6	2.5	0.7	2.3
Hickory	6.3	4.5	1.0	1.5	1.3	4.3
Birch	0.7	4.5	0.1	2.8	--	1.2
Black locust	3.5	3.9	0.9	1.0	1.3	2.7
Dogwood-persimmon	0.1	0.2	0.1	0.2	0.2	0.2
Chestnut	35.6	22.4	3.3	7.3	1.1	23.4
Scrub hardwoods	2.0	1.6	1.0	1.3	1.0	1.6
Other hardwoods	3.8	11.0	1.1	3.3	1.8	3.9
Total	100.0	100.0	100.0	100.0	100.0	100.0

*Includes hemlock-hardwoods and spruce-fir types.

**Net cubic volume outside bark of sound trees 5.0 inches d.b.h. and larger.

The white pine-hardwoods type which includes 81,000 acres of hemlock-hardwoods and 23,000 acres of spruce and fir with the 170,000 acres of eastern white pine-hardwoods, amounts altogether to nearly 8 percent of the forest land. The hemlock-hardwoods forest occurs in the coves along the small mountain streams and is widely distributed. The spruce-fir forest

consists of a few remnants of the original spruce forest located at the higher altitudes in the Black, Balsam, Unaka, and Blue Ridge Mountains. This type formerly occupied approximately 150,000 acres but clear-cutting followed by severe fires have eliminated most of the spruce-fir forest and it has been replaced by dense, scrubby stands of firecherry and yellow birch. Stands of eastern white pine in mixture with hardwoods are scattered throughout the unit but are most common on the eastern slopes of the Blue Ridge Mountains. Eastern white pine and eastern hemlock are the leading softwoods in the white pine-hardwoods type and the red and white oaks, yellowpoplar, red maple, and dead chestnut are the more abundant hardwoods.

The Virginia pine-hardwoods type, which occupies only five percent of the forest land, occurs most abundantly in Wilkes, Caldwell, Burke, and McDowell Counties. West of the Blue Ridge Mountains Virginia pine often grows with shortleaf pine but it seldom is the dominant tree in the stand. About one-half of the stand volume is composed of other species, notably shortleaf pine, yellowpoplar, red and white oaks, and black locust.

Forest Conditions

In addition to the type classification the forest cover was further classified into forest conditions on the basis of tree-diameter, age, volume-per-acre, and cutting history. It was found that old-growth saw timber occupied 11 percent of the land, sawlog-size second growth only 36 percent, and under-sawlog-size second growth 53 percent (table 4).

Very few large acreages of old-growth timber remain. A few tracts are being operated by the larger band mills in the unit such as the Bemis Lumber Company at Robbinsville and the Gloucester Lumber Company at Rosman. Other old-growth stands are estate properties, held chiefly for their recreational values, and scattered blocks of old-growth saw timber in National Forests. Among the latter is an area along Big Ivey Creek in Buncombe County, an area in Sherwood Forest in Haywood County, and the Fires Creek watershed in Clay County. Farmers also own small patches of old-growth timber, most of it in rather inaccessible locations.

A large part of the old growth has the size and quality of virgin timber but it is not primeval forest untouched by the lumberman, since about two-thirds of the old growth has been sorted over in recent years for selected species or sizes. An even larger proportion has undoubtedly been cut very lightly in the past because when lumbering first began it was the practice to take out only the walnut, cherry, and the finest yellowpoplar, eastern white pine, basswood and white oak. The present old-growth timber is largely in the upland hardwoods type. That part of it growing on the lower slopes is normally excellent timber but the old growth on the high, dry ridges is usually of very poor quality.

Sawlog-size stands of second-growth timber are distributed rather uniformly throughout the unit although they are not the most prevalent forest condition (table 4). About one-third of these stands have had part of their volume removed in light cuttings. The shortleaf pine-hardwoods were least subject to this culling process. One-half of the merchantable second growth is in the upland hardwoods type and one-fourth is in the shortleaf pine-hardwoods.

Stands of young timber below sawlog size occupy the largest acreage and form the most noticeable component of the forest. These young stands are the prospective sources of supply of the wood-using industries and the success with which they are protected and managed will determine the future importance of the forest industries in this unit. Most of the young stands have advanced beyond the reproduction stage and less than one percent of the forest land is clear-cut and not restocking. Nearly 70 percent of the under-sawlog-size forest is the upland hardwoods type.

Table 4. - Forest area classified according to forest condition and forest type, 1938

Forest condition	Upland hardwoods	Cove hardwoods	Shortleaf pine-hdwds.	White pine hdwds.	Virginia pine-hdwds.	Total all types	Proportion of total
	Acres						Percent
Sawlog size:							
Old growth:							
Uncut	96,200	12,300	6,500	31,000	--	146,000	4.1
Partly cut	169,600	31,800	19,600	19,500	--	240,500	6.8
Total	265,800	44,100	26,100	50,500	--	386,500	10.9
Second growth:							
Uncut	391,400	70,100	243,000	90,500	43,200	838,200	23.7
Partly cut	241,400	44,800	88,100	58,700	21,200	454,200	12.8
Total	632,800	114,900	331,100	149,200	64,400	1,292,400	36.5
Total sawlog size	898,600	159,000	357,200	199,700	64,400	1,678,900	47.4
Under sawlog size:							
Second growth	1,172,600	154,900	231,600	67,700	106,000	1,732,800	48.9
Reproduction	49,700	8,200	26,100	3,200	20,400	107,600	3.0
Clear-cut	20,400	800	--	3,300	--	24,500	0.7
Total under sawlog size	1,242,700	163,900	257,700	74,200	126,400	1,864,900	52.6
Total all conditions	2,141,300	322,900	614,900	273,900	190,800	3,543,800	100.0
Percent of total	60.4	9.1	17.4	7.7	5.4	100.0	

Site Quality

Forest productivity depends in a large measure upon the quality of the site. In the mountain region site is an important factor because a variety of soil, climatic, and topographic conditions are induced by the wide range in land elevations. The forest land was classified by the Survey into three site classes, good, fair, and poor, using soil and moisture conditions, topographic aspect, elevation, and merchantable height and form of trees as measures of the timber producing capacity.

In table 5 the land area within each forest type has been classified according to site quality. It is immediately apparent that only a small part of the forest land constitutes an above-average site for timber production. As would be expected, the largest absolute and relative acreage of good site is in the cove hardwoods type. The smallest acreage is in the Virginia pine-hardwoods type. About 80 percent of all the forest land is a fair site that will produce mature trees averaging two to three logs. The poor site is generally confined to the dry upper slopes and produces timber of limited commercial value.

Table 5. - Forest area classified according to forest type and site quality, 1938

Forest type	Good (Site 1)	Fair (Site 2)	Poor (Site 3)	Total	Proportion in good site
	Acres				Percent
Upland hardwoods	115,800	1,767,800	257,700	2,141,300	5.4
Cove hardwoods	163,900	157,400	1,600	322,900	50.8
Shortleaf pine-hardwoods	26,100	496,600	92,200	614,900	4.2
White pine-hardwoods*	62,800	202,200	8,900	273,900	22.9
Virginia pine-hardwoods	9,800	175,300	5,700	190,800	5.1
Total	378,400	2,799,300	366,100	3,543,800	--
Percent of total	10.7	79.0	10.3	100.0	

*Includes 81,500 acres of hemlock-hardwoods and 22,800 acres of spruce-fir types.

Age

A majority of the forest stands are uneven-aged. Reproduction, saplings, poles and saw-timber trees are often associated in an all-aged forest. Exceptions are the practically even-aged old-growth stands and the second-growth stands that have rapidly occupied clear-cut land and abandoned fields. Although there is a wide range of ages within most forest stands the age of the trees governing the forest type and condition is a fairly accurate basis for estimating the time required to grow the various classes of timber.

Stands of reproduction are customarily less than 20 years old. Undersawlog-size second growth is usually 20 to 50 years old and most of the second-growth saw timber is 50 to 100 years old. The old-growth stands are 100 to 350 years of age. In general, the trees in the pine and cove hardwoods types are at the lower extreme of the age-range in a given forest condition while the trees in the upland hardwoods type may be many years older than indicated above. About 45 percent of the forest land is occupied by stands less than 40 years old, 35 percent is occupied by stands 40 to 80 years old, and 20 percent is stocked with stands more than 80 years of age. Practically one-half of the forest is too young to contain much saw timber.

Stocking

In the mountain region volume-per-acre is influenced to a great extent by site (table 6). In the coves and on the lower moist slopes, where soil and moisture conditions are favorable for growth, the trees are naturally closely spaced with narrow crowns, and long, clear boles. On the drier sites there are fewer trees per acre, the crowns are larger, and the merchantable stems are shorter. The dry ridge-tops support only an open stand of short, poorly-formed, and often defective trees.

Table 6. - Average volumes per acre by forest type and site-class in uncut second-growth stands, 1938

Forest type and site-class	Under-sawlog-size stands			Sawlog-size stands		
	Well-stocked	Average-stocked	Stocking of average stands	Well-stocked	Average-stocked	Stocking of average stands
	Cords	Cords	Percent	Cords	Cords	Percent
Upland hardwoods:						
Good site	9.2	4.8	52.2	19.7	12.6	64.0
Fair site	6.7	3.3	49.3	13.9	8.6	61.9
Cove hardwoods:						
Good site	12.1	5.5	45.5	34.1	18.6	54.5
Fair site	8.8	3.7	42.0	19.3	12.2	63.2
Shortleaf pine-hardwoods:						
Good site	18.4	13.1	71.2	43.2	26.6	61.6
Fair site	10.8	4.2	38.9	29.4	15.3	52.0

The original forests were probably fully-stocked. Lumbermen commonly cut 20,000 board feet per acre from the coves and a 40-acre tract cut in 1912 near Looking Glass Rock in Transylvania County produced 40,000 board feet of yellowpoplar per acre exclusive of other species.5/ On the moist slopes the stands averaged about 9,000 board feet per acre and on the dry slopes about 3,000 feet.

The average second-growth saw-timber stands of the present do not approach such stocking, partly because they are immature and partly because of the volume lost through the chestnut blight. Until recent years a great deal of the cut-over forest land was also burned over almost annually. As a result many of the second-growth seedlings and saplings were killed and the under-sawlog-size stands were usually badly fire-scarred. Mortality has consequently been high and defective slow-growing trees make up a high proportion of the stand. Under such conditions the growing space has not been fully utilized.

5/Frothingham, E. H., 1931. Timber growing and logging practice in the Southern Appalachian Region. U. S. Dept. Agr. Tech. Bul. 250. 93 p. illus.

Reference to table 6 shows that most of the average stands have less than two-thirds the stocking of well-stocked stands. The sound-tree values given here for well-stocked stands are based upon the volume of the best 20 percent of existing stands, weighted by age, in the three forest types and the two site-classes and probably do not represent the stocking attainable under intensive forest management.

Forest Fires

Forest fires are a serious problem in the mountain region because the effects of past fires add to the problems of forest management and the prevention and suppression of new fires requires constant vigilance. Fires are most common between October 15 and December 15, and from March 1 to about May 15, corresponding with the fall period when new-fallen dry leaves are on the ground and with the spring period between the cessation of the winter rains and the growth of new foilage. Most of the fires burn only in the leaf litter, crown fires occur infrequently and only in the extremely dry seasons.

Damage to the forest occurs in several ways. Reproduction and young trees are killed outright, the proportion of undesirable hardwood sprouts on reproduction areas is increased, stand composition is often changed for the worse, and basal fire-scars cause serious losses in volume because many of the scars become infected with wood-decaying fungi. It has been determined that mortality and cull damage caused by a single average fire amounts to $1.55 per average acre of burned-over forest land.6/ Fire-scarred, partially rotten hardwood trees occupy a large amount of growing space in the mountain forests and their elimination is one of the more difficult problems of management.

Continuous planning and action is required to protect the forests from the destructive effects of recurrent fires. Fire control organizations maintained on the Great Smoky Mountains National Park, the Cherokee Indian Reservation, and the Pisgah and Nantahala National Forests protect about one million acres of forest land. On private lands the North Carolina Division of Forestry provides fire protection with funds derived from private Forest Protective Associations and the County, State and Federal governments. In 1937-1938 the Division cooperated with 15 of the 21 counties and with two Forest Protective associations. Unrelenting effort on the part of all fire control agencies keeps the area burned over within reasonable limits. On the Boone Working Circle of the Pisgah National Forest the average annual burned acreage for the past 22 years has been only one-half of one percent of the protected land. This includes the severe fire year of 1926; since that year the annual loss has not exceeded one-quarter of one percent. The trend on private forest land is toward a gradual reduction in the number and size of fires, although bad fire seasons such as the dry fall of 1939 cause violent fluctuations in the downward trend. For example, the North Carolina Division of Forestry reported 68,000 acres of non-federal forest land burned over in the mountain region in the 1939 season, compared to 22,000 acres in 1938.

6/Unpublished data of the Appalachian Forest Experiment Station, Asheville, N. C.

VOLUME OF THE FOREST RESOURCES

The sound volume of all living trees and dead chestnut 5.0 inches d.b.h. or larger is included in the 1938 inventory of the forest resource. Estimates of the volume of sound wood (cull deducted) are given in board feet, cords, and cubic feet. Volumes expressed in board feet include only the sawlog portion of saw-timber trees. Softwood saw timber is at least 9.0 inches d.b.h.; yellowpoplar, basswood, ash, cherry, and walnut saw timber is at least 11.0 inches d.b.h.; and other hardwood saw timber is 13.0 inches d.b.h. or larger. Cordwood volumes (wood and bark) contain the sawlog portion of saw-timber trees, the cordwood material in the upper stems of softwood and the upper stems and limbs of hardwood saw timber, the sound stems of both softwood and hardwood under-sawlog-size trees, and the sound volume in cull trees. Under-sawlog-size trees range in diameter from 5.0 inches d.b.h. to saw-timber size. Cubic-foot volumes do not contain bark, otherwise the basis of estimate is the same as for cordwood.

In the following tables of volume certain species have been grouped together. On the basis of board-foot volume shortleaf pine contains 40 percent pitch pine, 20 percent table mountain pine, and a very small amount of eastern redcedar. The red spruce contains about one-fourth Fraser fir. White oak (Q. alba) constitutes 98 percent of the white oak volume, post oak the remainder. The red oaks are chiefly scarlet and black oak, southern red oak makes up only 4 percent of the board-foot volume. Yellow and black birch are almost equally represented in the birch group. In the cherry-ash-walnut group 80 percent of the volume is ash. The other hardwoods consist of blackgum, beech, buckeye, cucumber, sycamore, butternut, and sweetgum. Twenty-six percent of the other hardwood volume is blackgum and 17 percent is beech. The chestnut is dead standing timber sound enough for utilization. It accounts for about one-fourth of the hardwood lumber cut in the region but is shown separately because it is not a part of the hardwood growing stock.

Board-foot Volume

In 1938 the net volume of saw timber in the mountain region was 5.9 billion board feet, inclusive of dead chestnut, when scaled by the International $\frac{1}{4}$-inch rule. Using the Scribner rule the volume was only 5.3 billion feet and by the Doyle rule only 4.1 billion board feet (table 7). The International rule is used for subsequent tabulations of board-foot volume because it gives the most accurate estimate of the amount of green lumber that can be sawed from the saw-timber trees.

Value of species: Softwoods comprise two-fifths of the saw-timber volume in live trees. White and shortleaf pines are highest in value, usually ranging from $2.00 to $5.00 per thousand board feet stumpage. Virginia pine and hemlock are low-value species, seldom bringing more than $1.00 or $2.00 stumpage. Hemlock lumber is not much in demand and a large part of the low-grade hemlock timber cut in this unit is used for pulp. Red spruce is valuable for pulp but the volume is small.

Table 7. - Net volume by the International, Scribner, and Doyle log rules classified according to species-group, 1938*

Species-group	International**	Scribner	Doyle
	Thousand board feet		
Softwoods:			
Shortleaf pine	979,000	818,900	514,200
Eastern white pine	406,100	355,200	263,400
Virginia pine	217,700	179,200	104,100
Eastern hemlock	389,300	358,100	313,300
Red spruce	95,300	81,900	55,700
Total softwoods	2,087,400	1,793,300	1,250,700
Hardwoods:			
Yellowpoplar	451,800	404,600	313,700
Basswood	107,900	96,800	74,400
Sugar maple	54,200	49,600	41,000
Ash-cherry-walnut	52,700	46,800	34,700
Northern red oak	496,400	456,800	388,000
White oaks	303,800	278,100	230,100
Chestnut oak	428,500	393,100	327,800
Red oaks	504,100	455,000	352,700
Red maple	102,000	92,100	74,100
Hickory	189,800	172,600	136,300
Birch	79,500	72,100	57,600
Other hardwoods	251,900	229,800	190,700
Total hardwoods	3,022,600	2,747,400	2,221,100
Chestnut	800,100	740,700	650,200
Total all species	5,910,100	5,281,400	4,122,000

*Does not include volume of timber in Great Smoky Mountains National Park, estimated to be 794 million board feet by the Scribner log rule.

**The scale by this rule approximates green lumber tally.

Yellowpoplar is the most prized of the commonly used hardwoods, stumpage bringing $5.00 to $12.00 per thousand. Basswood, sugar maple, ash, black cherry, and walnut are in the same high-value category. The red and white oaks are cut irrespective of species in logging operations if the individual trees are of suitable quality. Northern red oak usually has the highest stumpage value of the oaks, although white oak good enough for tight cooperage brings a higher price. Chestnut oak has about one-half the stumpage value of northern red oak. Southern red and scarlet oaks are the poorest of the red oak group. Red maple, hickory, beech, birch, and black-gum bring little more than the low-grade oaks. Dead chestnut has a low stumpage value, seldom exceeding $2.00 per thousand board feet. Stands of high-grade timber readily accessible to roads occasionally bring more than the maximum stumpage values quoted.

Table 8. - Net volume by the International $\frac{1}{4}$-inch rule classified according to species-group and forest condition, 1938

Species-group	Sawlog size				Under sawlog size	Total	Proportion of total
	Old growth		Second growth				
	Uncut	Partly cut	Uncut	Partly cut			
	Thousand board feet						Percent
Softwoods:							
Shortleaf pine	30,400	53,700	654,700	160,700	79,500	979,000	19.1
White pine	32,400	36,300	206,300	109,000	22,100	406,100	7.9
Virginia pine	400	1,800	135,800	62,600	17,100	217,700	4.3
Hemlock & spruce	208,800	130,300	94,200	37,900	13,400	484,600	9.5
Total softwoods	272,000	222,100	1,091,000	370,200	132,100	1,087,400	40.8
Hardwoods:							
Yellowpoplar	72,000	44,900	236,300	62,000	36,600	451,800	8.8
Basswood	33,100	14,300	40,900	13,700	5,900	107,900	2.1
Sugar maple	19,200	18,100	2,700	9,400	4,800	54,200	1.1
Ash-cherry-walnut	1,400	15,000	16,100	13,900	6,300	52,700	1.0
Northern red oak	157,000	110,900	124,100	70,400	34,000	496,400	9.7
White oaks	59,800	73,200	96,600	53,400	20,800	303,800	6.0
Chestnut oak	123,200	122,200	106,600	36,200	40,300	428,500	8.4
Red oaks	27,500	80,900	233,800	102,500	59,400	504,100	9.9
Red maple	11,000	37,900	20,000	16,500	16,600	102,000	2.0
Hickory	18,500	59,900	52,000	35,000	24,400	189,800	3.7
Birch	19,900	22,000	16,900	11,600	9,100	79,500	1.6
Other hardwoods	37,300	73,500	68,600	48,900	23,600	251,900	4.9
Total hardwoods	579,900	672,800	1,014,600	473,500	281,800	3,022,600	59.2
Total live species	851,900	894,900	2,105,600	843,700	413,900	5,110,000	100.0
Percent of total	16.7	17.5	41.2	16.5	8.1	100.0	
Chestnut	149,500	127,000	166,200	71,800	285,600	800,100	

Volume by condition: About 24 percent of the softwood saw-timber volume is in old-growth stands, 70 percent is in sawlog-size second-growth stands, and 6 percent is in scattered trees in under-sawlog-size stands (table 8). More than two-thirds of the 494 million board feet of old growth is hemlock and spruce. The hemlock is scattered throughout the mountains, particularly in the less accessible coves. Frequently it was left when the other merchantable timber was cut. The spruce is all at high elevations in practically pure stands. As a source of pulpwood or lumber it is relatively unimportant. The second-growth saw timber is chiefly shortleaf, pitch, and white pine. The shortleaf pine yields good lumber and the location and volumes-per-acre of the stands are favorable for utilization. The pitch pine volume, included with shortleaf pine, is usually less desirable saw timber because many of the trees are of poor quality and often grow on extremely rough terrain. Second-growth white pine saw timber has a ready market but the volume is in scattered trees that must

be harvested in conjunction with other species. At present the saw-timber volume in under-sawlog-size stands is unimportant commercially because the volume-per-acre is negligible.

The distribution of the hardwood saw-timber volume by forest condition is unlike that of the softwoods. Old-growth stands contain 42 percent of the volume instead of 24 percent, sawlog-size second-growth stands contain only 49 percent, and under-sawlog-size stands 9 percent. About one-third of the chestnut volume is located in each of the three forest condition classes. The better-quality hardwoods, such as yellowpoplar, basswood, northern red oak, white oak, sugar maple, and ash make up about 60 percent of the volume in uncut old-growth stands, 50 percent in uncut second-growth stands, and only 40 percent in all under-sawlog-size stands.

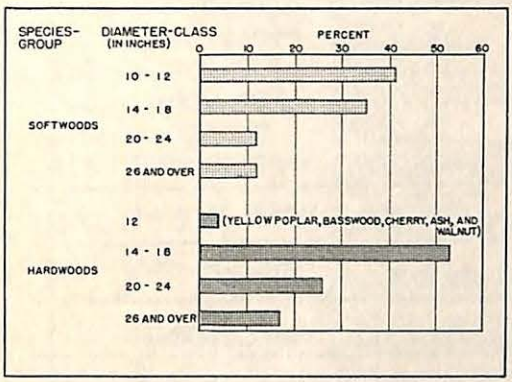

FIGURE 6- DIAMETER DISTRIBUTION OF BOARD-FOOT VOLUME

Volume by diameter class: Among the survey units of North Carolina this unit is unique in that it contains the greatest proportionate area of under-sawlog-size timber and also the greatest proportionate board-foot volume in the larger diameter-classes. Twenty-four percent of the softwood saw-timber volume is in trees larger than 20.0 inches d.b.h. (fig. 6) compared to only 16 percent of the volume in the Northern Coastal Plain where the proportion of large trees is above the average. Hemlock comprises most of the volume in large softwoods. In the hardwoods 43 percent of the volume is in trees larger than 20 inches.

The distribution of the hardwood volume by species-group and diameter-class is indicated in table 9. Since only the yellowpoplar, basswood, and ash were considered saw timber when 12.0 inches d.b.h. the volume in this size-class is small. Over one-half of the volume of sugar maple, northern red oak, and chestnut oak and about one-third of the volume of yellowpoplar and basswood are contained in trees 20.0 inches d.b.h. and larger. Nearly three-fourths of the red oak volume and two-thirds of the red maple, hickory, and birch volume is in trees of the 14, 16, and 18-inch diameter-classes. Species is often more reliable than size as an indicator of quality. Chestnut oak, with one-half of its volume in trees at least 20 inches in diameter yields less than 30 percent No. 1 common and better lumber, while yellowpoplar with only 34 percent of its volume in such large trees yields more than 50 percent of these better grades.

Table 9. - Net board-foot volume of the hardwood saw timber classified according to species-group and diameter-class, 1938

Species-group	Tree diameter-class (inches)				Total	Proportion of total
	12	14, 16, and 18	20, 22, and 24	26 and over		
	Thousand board feet					Percent
Yellowpoplar	95,900	202,200	81,900	71,800	451,800	14.9
Basswood	15,500	54,000	33,900	4,500	107,900	3.6
Sugar maple	--	24,700	20,800	8,700	54,200	1.8
Ash-cherry-walnut	12,900	26,200	11,200	2,400	52,700	1.7
Northern red oak	--	207,700	159,200	129,500	496,400	16.4
White oaks	--	151,500	85,900	66,400	303,800	10.1
Chestnut oak	--	206,200	114,300	108,000	428,500	14.2
Red oaks	--	362,100	119,300	22,700	504,100	16.7
Red maple	--	66,600	19,700	15,700	102,000	3.4
Hickory	--	119,300	54,600	15,900	189,800	6.3
Birch	--	48,400	20,900	10,200	79,500	2.6
Other hardwoods	--	136,700	55,100	60,100	251,900	8.3
Total hardwoods	124,300	1,605,600	776,800	515,900	3,022,600	100.0
Percent of total	4.1	53.1	25.7	17.1	100.0	
Chestnut saw timber	--	236,500	271,700	291,900	800,100	

Distribution by area, volume-per-acre, and site: The distribution of the board-foot volume in the sawlog-size stands has an important influence upon its utilization. In the hardwood types nearly 60 percent of the area is stocked with stands having a volume of less than 2,000 board feet per acre (fig. 7). About three-fourths of the volume in the hardwood types is located on 435,000 acres stocked with more than 2,000 board feet per acre. In general, this acreage will provide the most profitable logging chances.

Volumes-per-acre are heavier in the saw-timber stands of the pine-hardwood types where only 38 percent of the acreage is stocked with less than 2,000 board feet per acre. Eighty-six percent of the volume occurs on the 383,000 acres with heavier stocking.

Combining all types in the sawlog-size condition, 78 percent of the board-foot volume is in stands of more than 2,000 feet per acre but these stands occupy only one-half of the saw-timber acreage. The remaining land is too poorly stocked to provide much saw timber for utilization and reestablishing a satisfactory volume of growing stock on this land is a fundamental problem of forest management.

Site quality has a strong influence upon the volume of growing stock per acre. In figure 7 it is obvious that the good sites (site 1) have the smallest proportionate area with less than 2,000 board feet per acre and the poorest sites have the largest. Likewise the good sites have a high proportion of heavy stands while no stands of more than 6,000 board feet per acre were found on the poorest sites.

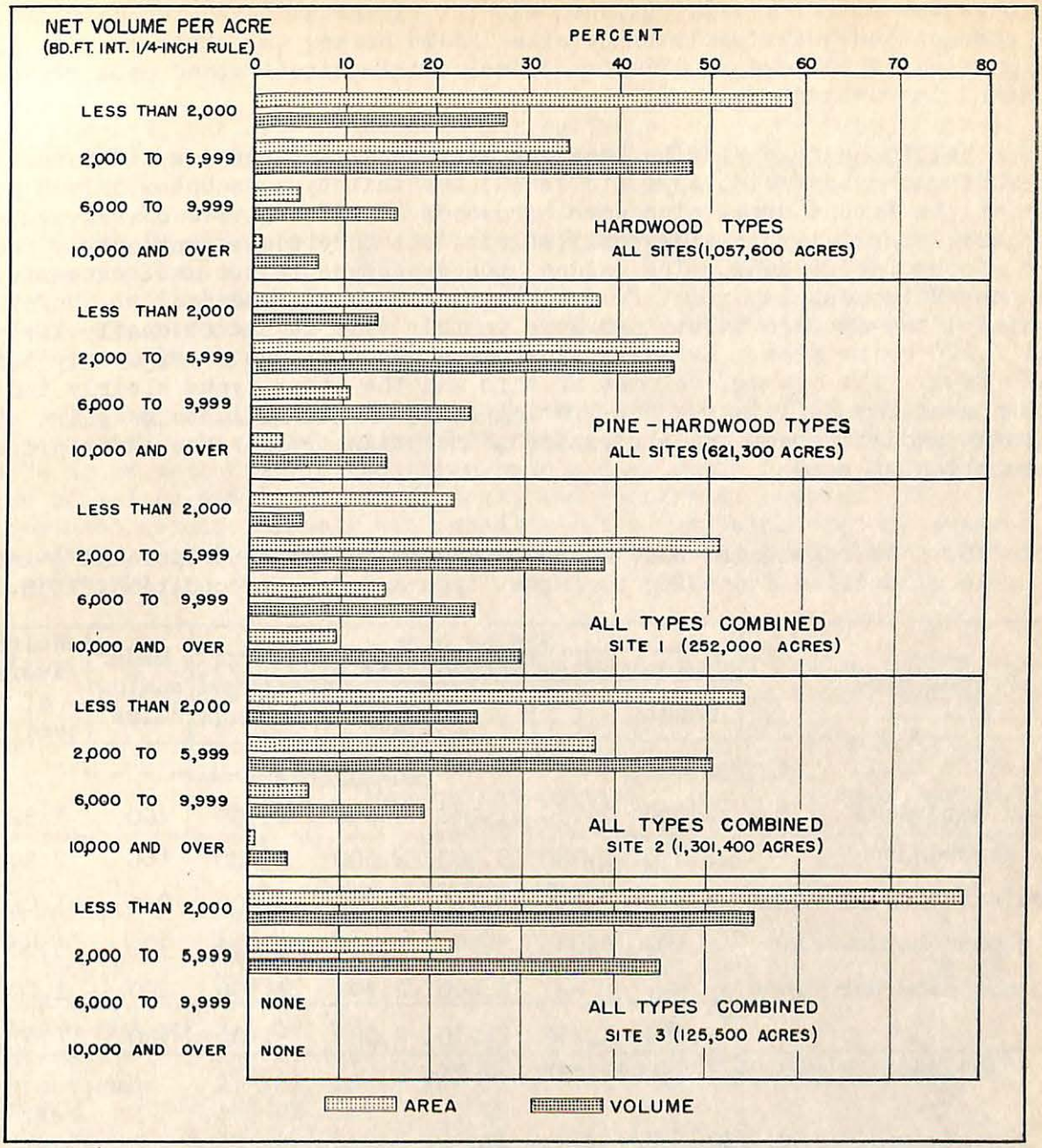

FIGURE 7.— DISTRIBUTION OF AREA AND BOARD-FOOT VOLUME IN THE SAWLOG-SIZE CONDITIONS BY SITE-CLASS AND VOLUME OF SAW TIMBER PER ACRE.

It is apparent that the site 3 land not only has very poor stocking but the nature of the site precludes any great improvement in timber yields. In general, the land classified as site 2 will grow commercial crops of timber. There are about 700,000 acres of land in this site-class with less than 2,000 board feet of growing stock per acre. On part of this land the board-foot volume will be considerably increased in the next 20 years by good-quality trees now below sawlog size. On other areas most of the increase in volume will accrue from trees of inferior quality. In either case the improvement of the growing stock will depend upon fire protection

and development of ways to utilize, without financial loss, the poor quality species and individuals. The site 1 land offers the best opportunity for growing timber crops. Timber stands on this site respond most rapidly to stand improvement measures.

Volumes per acre: The heaviest average volume per acre is found in the white pine-hardwoods type (table 10) but this type occupies only 8 percent of the forest area. The cove hardwoods likewise have a heavy volume per acre, especially in old-growth stands, but they too occupy only 9 percent of the forest land. The upland hardwoods type is the most extensive and therefore most important from the forest resource standpoint. Unfortunately, the average volume per acre in this type is exceptionally low, only 1,320 board feet. Even the old-growth uncut stands average only 5,640 board feet. The average volumes of this and the other types clearly indicate a need for building up the growing stock if timber is to be grown at a profit and if forest industries are to maintain or increase their present consumption of wood.

Table 10. - Average board-foot volume per acre by the International $\frac{1}{4}$-inch rule classified according to forest type and forest condition, 1938.

Forest type	Sawlog size					Under sawlog size	Weighted average of all conditions
	Old growth		Second growth		Weighted average		
	Uncut	Partly cut	Uncut	Partly cut			
	Board feet*						
Upland hardwoods	5,640	3,750	1,960	1,590	2,590	400	1,320
Cove hardwoods	11,270	4,920	3,900	2,500	4,280	560	2,390
Shortleaf pine-hardwoods	5,880	3,670	3,140	2,250	3,000	240	1,840
White pine-hardwoods	9,100	8,080	3,890	2,910	4,820	320	3,600
Virginia pine-hardwoods	--	--	2,690	2,390	2,590	200	1,000
	6,860	4,250	2,710	2,020	3,100	380	1,670

*Includes volume of chestnut saw timber.

Economic availability[7/]. It is impossible to give an accurate estimate of the amount of board-foot volume that can be manufactured profitably at present without a detailed field examination of each logging unit. Such a procedure was financially impractical on a unit-wide basis. Also, because of the immaturity of a large part of the sawlog-size stands it seemed advisable to obtain an approximation of the board-foot volume operable both now and potentially. Accordingly, careful field observations were made of timber stands, cutting practices, and logging operations and on this basis it was estimated that at least 85 percent of the board-foot volume is

7/This section based on a report prepared by James W. Girard, Asst. Director, Forest Survey.

operable either now or potentially. In general, potentially operable stands will require a growing period of at least 20 more years before they will support an economic logging operation.

Several factors influenced this estimate. A large proportion of the second-growth sawlog-size stands are not now operable because of low volumes per acre and a preponderance of small, low-value trees. Many of these stands will become operable, however, before the present volume of available timber is exhausted. Practically all of the second-growth timber is topographically accessible because most of it is on land which has been logged or cultivated. If the most difficult logging chances now being operated are accepted as the limitation of future developments there is very little economically unavailable timber.

Quality of hardwood saw timber: An estimate of the quality of the hardwood saw timber was obtained by grading the logs in several thousand sample trees well distributed throughout the mountain region and representative of all forest types, conditions, and commercial species. The log grades used compare closely with grading rules now being used by several band sawmills in this unit. A description of the log grades is included in the glossary.

Table 11. - Proportionate distribution of the hardwood volume by log grade and the estimated yield of No. 1 common and better lumber, 1938*

	Old growth				Second growth			
	Log grade			Yield of No. 1 common and better lumber	Log grade			Yield of No. 1 common and better lumber
	1	2	3		1	2	3	
	Percent							
Yellowpoplar	54	20	26	65	24	26	50	45
Basswood	50	24	26	60	40	20	40	55
Sugar maple	40	24	36	45	30	25	45	38
Cherry-ash	54	22	24	63	40	30	30	55
Northern red oak	54	19	27	62	46	21	33	55
White oaks	24	23	53	35	10	24	66	30
Chestnut oak	27	25	48	25	10	23	67	30
Red oaks	15	21	64	30	10	21	69	32
Red maple	38	27	35	47	25	26	49	40
Birch	31	23	46	54	20	30	50	45
Other hardwoods	20	30	50	40	15	30	55	30

*Based on data obtained by James W. Girard, Asst. Director, Forest Survey.

The results obtained provide a reliable indication of the quality of the saw timber. Table 11 shows the proportionate distribution of the volume of each important hardwood species by log grade for both old-growth and second-growth timber. For instance, 54 percent of the old-growth yellow-poplar volume is in No. 1 logs, 20 percent is in No. 2 logs, and 26 percent

is in No. 3 logs. At least one-half of the old-growth yellowpoplar, basswood, black cherry, ash, and northern red oak volume, and over 45 percent of the second-growth northern red oak is in first quality logs. The white oaks, chestnut oak, and the red oaks have a high proportion of their volume in No. 3 logs in both old-growth and second-growth timber. About 35 percent of the old-growth volume and about 20 percent of the second-growth volume in all species is in No. 1 logs.

In addition, the table shows for each species the yield, in percent of total volume, of No. 1 common and better lumber. These yields are obtained from the average mill run of logs by band mills cutting hardwood in the region. The highest proportion, 65 percent, of the better grades is obtained from old-growth yellowpoplar and the lowest, 25 percent, from old-growth chestnut oak. On the average, 45 percent of the lumber cut from old-growth hardwood is No. 1 common or better, compared to 39 percent of the lumber cut from second-growth timber. The disparity is not great and many operators prefer second-growth timber in view of the economies in logging and milling.

Cordwood Volume

Because more than one-half of the forest land is stocked with under-sawlog-size timber, cordwood volumes provide a more comprehensive medium for measuring the wood resource. With chestnut, the total net volume of all trees 5.0 inches d.b.h. and larger, including saw timber, is 51.3 million cords (table 12). Forty-two percent of the volume is in the stems and limbs of sawlog-size trees, 28 percent is in sound trees under sawlog size, and 30 percent is sound material in cull trees.

The total cordwood volume of all living trees, including culls, is about 40 million cords. Softwoods comprise only one-fourth of this volume. In the shortleaf pine species-group the volume of sawlog material greatly exceeds that in the smaller trees. On the other hand, more than 60 percent of the Virginia pine volume is in under-sawlog-size and cull trees. Sawlog material makes up a major portion of the other softwood volume, which is mostly hemlock and white pine.

Three-fourths of the cordwood volume in living trees is hardwood. Sound trees under sawlog size contain more wood than hardwood sawlogs and the volume in cull trees almost equals that in saw-timber material. Cull trees are especially abundant in this unit, making up 28 percent of the cordwood volume of the hardwoods compared to 24 percent in the Coastal Plain and 20 percent in the Piedmont. Forest productivity will remain at a low level so long as cull trees make up such a large proportion of the growing stock. It is extremely difficult to remove cull trees from a forest and break even financially since markets for cull material are hard to develop. A larger quantity of cull hardwood would be used for domestic heating if it compared in performance and cost with coal. Recently, wood-burning stoves of an improved design have been placed upon the market and a greater use of these stoves in this unit would greatly increase the opportunity for disposal of cull hardwoods. It is also possible that some of the cull volume can be used in tanning extract plants. About one-fifth of the cull volume is chestnut oak. The bark of this species is commonly used

for making tanning extract but so far none of the extract plants in this unit use the wood. In northern Alabama chestnut oak wood is used commercially in combination with chestnut for this purpose. If this practice were followed here a much larger quantity of raw material would be available, and a new market for some cull chestnut oak would be at hand.

Table 12. - Net cordwood volume of all sound material including bark, 1938

Species-group	Sawlog-size trees		Sound trees under sawlog size	Cull trees	Total all classes	Proportion of total
	Sawlog material	Upper stems				
	Cords					Percent
Softwoods:						
Shortleaf pine	2,414,300	628,000	1,577,500	319,000	4,938,800	12.4
Virginia pine	466,900	143,100	666,500	331,700	1,608,200	4.0
Other conifers	1,989,700	393,900	570,900	239,300	3,193,800	8.0
Total softwoods	4,870,900	1,165,000	2,814,900	890,000	9,740,800	24.4
Hardwoods:						
Yellowpoplar-basswood	1,421,600	471,300	1,000,200	358,200	3,251,300	8.2
Ash-cherry-walnut*	284,400	125,900	228,900	178,300	817,500	2.1
Northern red oak	1,236,000	606,000	548,600	728,600	3,119,200	7.8
White oaks	845,900	397,000	1,198,100	789,700	3,230,700	8.1
Chestnut oak	1,376,600	528,500	885,200	1,826,000	4,616,300	11.5
Red oaks	1,552,400	681,500	2,075,700	1,193,900	5,503,500	13.8
Black locust**	--	--	1,002,000	148,100	1,150,100	2.9
Other hardwoods	1,966,400	720,900	2,545,600	3,215,700	8,448,600	21.2
Total hardwoods	8,683,300	3,531,100	9,484,300	8,438,500	30,137,200	75.6
Total all species	13,554,200	4,696,100	12,299,200	9,328,500	39,878,000	100.0
Percent of total	34.0	11.8	30.8	23.4	100.0	
Chestnut	2,502,700	989,400	2,086,400	5,891,900***	11,470,400	

*Includes sugar maple.
**All saw-timber volume included with under-sawlog-size trees.
***Sawlog-size trees suitable for extract wood including upper stems.

Volume by diameter-class: The cordwood volumes of table 13 do not include the sound volume in living cull trees or the volume in upper stems and limbs of sawlog-size hardwoods, hence the living tree volume is 12.9 million cords less than is shown in table 12. Chestnut trees culled for saw timber but suitable for extract wood constitute the chestnut cordwood volume in sawlog-size trees. The sound-tree volume of both the softwoods and the hardwoods is fairly evenly distributed between the diameter classes. By species-group there is some variation. Northern red oak and chestnut oak have a relatively small volume in 6- and 8-inch trees compared to the volume in trees 20 inches and larger. The reverse is true in the white oak and red oak group. More than one-half of the other hardwoods volume is in trees below saw-timber size. Four-fifths of the chestnut wood is in trees 14.0 inches d.b.h. and larger but only 2.5 million cords are suitable for lumber. The bulk of this volume is in cull trees usable for extract wood.

Table 13. - Net cordwood volume of sound trees classified according to species-group and diameter-class, 1938*

Species-group	Tree diameter-class (inches)				Total	Proportion of total
	6 - 8	10 - 12	14 - 18	20 and over		
	Cords					Percent
Softwoods:						
Shortleaf pine	1,577,500	1,807,200	1,075,900	159,200	4,619,800	17.1
Virginia pine	666,500	451,900	151,800	6,300	1,276,500	4.7
Other conifers	570,900	584,800	781,600	1,017,200	2,954,500	11.0
Total softwoods	2,814,900	2,843,900	2,009,300	1,182,700	8,850,800	32.8
Hardwoods:						
Yellowpoplar-basswood	640,100	674,400	656,700	450,600	2,421,800	9.0
Ash-cherry-walnut	136,600	131,100	135,700	109,900	513,300	1.9
Northern red oak	236,300	312,300	556,800	679,200	1,784,600	6.6
White oaks	600,700	597,400	463,000	382,900	2,044,000	7.6
Chestnut oak	362,300	522,900	736,600	640,000	2,261,800	8.4
Red oaks	904,800	1,170,900	1,149,900	402,500	3,628,100	13.4
Black locust	363,000	380,700	213,200	45,100	1,002,000	3.7
Other hardwoods	1,249,200	1,295,500	1,265,400	701,900	4,512,000	16.6
Total hardwoods	4,493,000	5,085,200	5,177,300	3,412,100	18,167,600	67.2
Total live species	7,307,900	7,929,100	7,186,600	4,594,800	27,018,400	100.0
Percent of total	27.0	29.4	26.6	17.0	100.0	
Chestnut saw timber	--	--	816,200	1,686,500	2,502,700	--
Chestnut cordwood	734,000	1,352,400	2,166,600**	3,725,300**	7,978,300	--

*Cull trees, upper stems and limbs of sawlog-size hardwoods not included.
**Cull trees suitable for extract wood, including upper stems.

Volume per acre: The average volume per acre of all forest types and conditions is 10.8 cords (table 14). This includes the volume of dead chestnut but does not include cull trees or upper stems and limbs of sawlog-size hardwoods. Sawlog-size stands average 16.0 cords per acre, varying from 27.2 in the old-growth uncut condition to 12.6 in the second-growth partly-cut stands. The heaviest average volume per acre occurs in the cove hardwoods type and is composed almost entirely of hardwoods and chestnut. The average volume of the white pine-hardwoods type is nearly as great, however, and is composed of a wider variety of species. Under-sawlog-size stands, which occupy 53 percent of the forest land, contain on the average only 3.5 cords of growing trees per acre.

The stand of chestnut averages 3.5 or more cords per acre in the upland and cove hardwood types but is much less plentiful in the softwood types. It is noticeably more abundant in the old-growth condition and the average volume on the 310,000 acres of old growth in the hardwood types is 8.3 cords.

Table 14. - Average cordwood volume per acre classified according to forest type, species-group, and forest condition, 1938*

Forest type and species-group	Sawlog size					Under sawlog size**	Weighted average of all conditions
	Old growth		Second growth		Weighted average		
	Uncut	Partly cut	Uncut	Partly cut			
	Cords						
Upland hardwoods:							
Softwoods	0.5	0.5	0.4	0.4	0.4	0.2	0.3
Hardwoods	14.2	11.4	8.1	7.7	9.3	3.0	5.6
Chestnut	11.3	6.9	4.7	3.9	5.6	3.7	4.5
Total	26.0	18.8	13.2	12.0	15.3	6.9	10.4
Cove hardwoods:							
Softwoods	0.9	1.2	0.4	0.3	0.6	0.2	0.4
Hardwoods	25.1	13.0	15.5	10.5	14.3	4.4	9.2
Chestnut	11.7	5.9	3.8	4.3	5.0	2.3	3.6
Total	37.7	20.1	19.7	15.1	19.9	6.9	13.2
Shortleaf pine-hardwoods:							
Softwoods	14.4	8.6	11.9	7.7	10.8	2.9	7.4
Hardwoods	2.9	4.4	2.8	3.9	3.1	1.1	2.3
Chestnut	1.1	1.1	0.5	0.4	0.5	0.4	0.5
Total	18.4	14.1	15.2	12.0	14.4	4.4	10.2
White pine-hardwoods:							
Softwoods	19.4	16.0	10.3	8.7	11.8	2.0	9.1
Hardwoods	6.8	5.5	5.7	5.1	5.7	2.3	4.8
Chestnut	2.3	2.7	1.9	0.9	1.7	1.0	1.5
Total	28.5	24.2	17.9	14.7	19.2	5.3	15.4
Virginia pine-hardwoods:							
Softwoods	--	--	9.6	8.7	9.4	3.4	5.4
Hardwoods	--	--	4.5	3.5	4.1	0.9	2.0
Chestnut	--	--	0.3	0.4	0.3	--	0.1
Total	--	--	14.4	12.6	13.8	4.3	7.5
All types:							
Softwoods	5.1	2.5	5.3	3.3	4.4	0.8	2.5
Hardwoods	13.1	10.6	6.7	6.6	7.8	2.7	5.1
Chestnut	9.0	5.9	2.9	2.7	3.8	2.7	3.2
Average all types	27.2	19.0	14.9	12.6	16.0	6.2	10.8

*Cull trees, upper stems and limbs of sawlog-size hardwoods not included.
**Includes reproduction and clear-cut conditions.

Cubic-foot Volume

The net volume of sound wood in trees 5.0 inches d.b.h. and larger, exclusive of chestnut, has been summarized in cubic feet in table 15. The cubic foot is a more accurate measure of wood volumes than the board foot or cord and, since bark is not included, the data provide a very reliable estimate of the volume distribution between tree classes and species groups.

Table 15. - Net cubic-foot volume of all sound wood, without bark, 1938

Species-group	Sawlog-size trees		Sound trees under sawlog size	Cull trees	Total all classes	Proportion of total
	Sawlog material	Upper stems				
	Thousand cubic feet					Percent
Softwoods:						
Shortleaf pine	175,070	45,170	106,660	22,570	349,470	13.4
Virginia pine	33,920	10,350	46,780	23,660	114,710	4.4
Other conifers	149,170	29,270	42,640	17,910	238,990	9.2
Total softwoods	358,160	84,790	196,080	64,140	703,170	27.0
Hardwoods:						
Yellowpoplar-basswood	93,300	27,220	60,620	22,900	204,040	7.8
Ash-cherry-walnut*	18,770	7,250	13,910	11,420	51,350	2.0
Northern red oak	82,480	35,400	33,750	47,730	199,360	7.7
White oaks	56,170	23,120	73,380	50,420	203,090	7.8
Chestnut oak	91,490	30,800	54,480	118,480	295,250	11.3
Red oaks	102,110	39,250	127,590	76,000	344,950	13.2
Black locust**	--	--	62,560	9,240	71,800	2.8
Other hardwoods	129,960	41,780	156,000	204,930	532,670	20.4
Total hardwoods	574,280	204,820	582,290	541,120	1,902,510	73.0
Total live species	932,440	289,610	778,370	605,260	2,605,680	100.0
Percent of total	35.8	11.1	29.9	23.2	100.0	

*Includes sugar maple.
**All saw-timber volume included with under-sawlog-size trees.

Supply of Tanning Material

Chestnut wood, chestnut oak bark, and hemlock bark are the important tanning extract materials cut from the mountain forests. Any estimate of the total supply of these materials must be tempered by the realization that part of the chestnut will be used for saw timber and part will decay before it is utilized. Some of the chestnut oak and hemlock bark will also be wasted when unpeeled logs are sawed for lumber. Also much of this material is in National Forests where it will be cut on a management basis over a period of years. As shown in previous tables, about 2.5 million cords of dead chestnut are still suitable for saw timber and almost 8 million

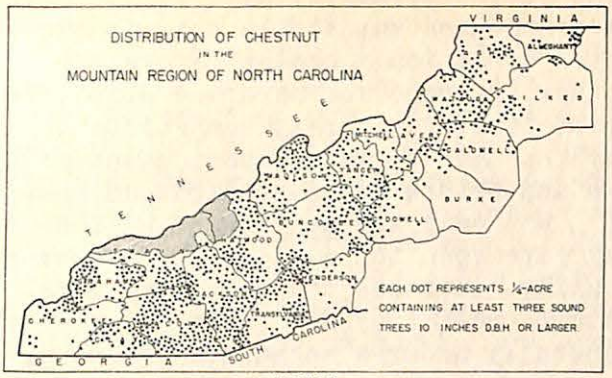

FIGURE 8

cords are suitable only for extract wood. The location of the principal supply of chestnut is shown in figure 8. Estimates of the quantity of bark obtained by applying a conversion factor to the board-foot volume of standing timber are necessarily inexact. For chestnut oak the factor used was 2,240 pounds of bark per thousand board feet by the Scribner rule and for hemlock it was 1,800 pounds per thousand feet. On these bases there are about 440,000 tons of chestnut oak bark and 320,000 tons of hemlock bark. It is estimated that there are an additional 400,000 tons of chestnut oak bark on cull trees, many of which are on the higher, more inaccessible ridges.

INCREMENT OF THE FOREST

Current increment is the net volume of wood produced by the forest growing stock in a single year, 1938 in this report. The board-foot growing stock consists of all sound softwood trees 9.0 inches d.b.h. and larger, all sound yellowpoplar, basswood, black cherry, ash, and walnut trees 11.0 inches d.b.h. and larger, and all other sound hardwood trees 13.0 inches d.b.h. and larger, exclusive of specialty woods such as dogwood and black locust. The growing stock expressed in cords and cubic feet includes all sound trees at least 5.0 inches d.b.h. The 4-inch trees becoming 5.0 inches or more during the year are included in cordwood and cubic-foot tabulations of increment and the under-sawlog-size softwoods and hardwoods that become saw-timber size are included in board-foot increment. The volume in cull trees, chestnut, and in the upper stems and limbs of sawlog-size hardwoods is not considered growing-stock material.

The Interrelation of the Elements of Increment

Increment is the resultant of two opposing factors -- the volume gained by growth and the volume lost through mortality. Total annual growth is composed of (1) the volume recruited from small trees which grow into merchantable sizes, and (2) the volume added by growth to individual trees already of merchantable size, including growth on utilized trees up to the time of their removal from the stand. Mortality consists of the volume lost through the natural death of sound trees.

The mortality in old-growth softwoods in this unit is outstanding (fig. 9) amounting to 147 percent of the total board-foot growth. In addition to being an exceptionally high mortality loss, this is unusual because it is one of the few instances discovered in this survey where mortality exceeds the growth in old-growth stands. In this case it can be attributed to the heavy mortality of large hemlock trees left in partly-cut old-growth stands. Changes in soil moisture and light intensities following cutting are believed to be the chief factors causing death of this

shade-tolerant species. Over 90 percent of the mortality loss in these partly-cut stands was hemlock, and the total loss was double that in the uncut old-growth, even though this latter condition contained a greater board-foot volume. Mortality in the other softwood and hardwood stands is not abnormally high and is chiefly due to fire, windthrow, competition, insects, and disease. Fire is probably the most serious causal agent of mortality because it has been extensive and severe and most hardwood species are susceptible to damage by fire. Not only are many trees killed outright but the basal wounds caused by fire open the way to rot-producing fungi which by reducing the trees' vitality, increase the mortality rate. Old age and overcrowding cause some natural mortality but these factors are rather unimportant in the young and generally under-stocked stands occupying over one-half of the forest land.

The importance of recruited volume as a factor of total growth is obvious in figure 9. In the under-sawlog-size softwood stands nearly 85 percent of the total board-foot growth results from trees attaining sufficient size during the year to be classed as saw timber. The proportion of recruited volume decreases in the older stands because of the predominance of sawlog-size trees. It makes up one-fourth of the total board-foot growth in the old-growth hardwoods, and more than compensates for the volume lost through mortality. This balancing effect of recruited volume upon mortality is too often overlooked in general discussions of increment in old-growth stands.

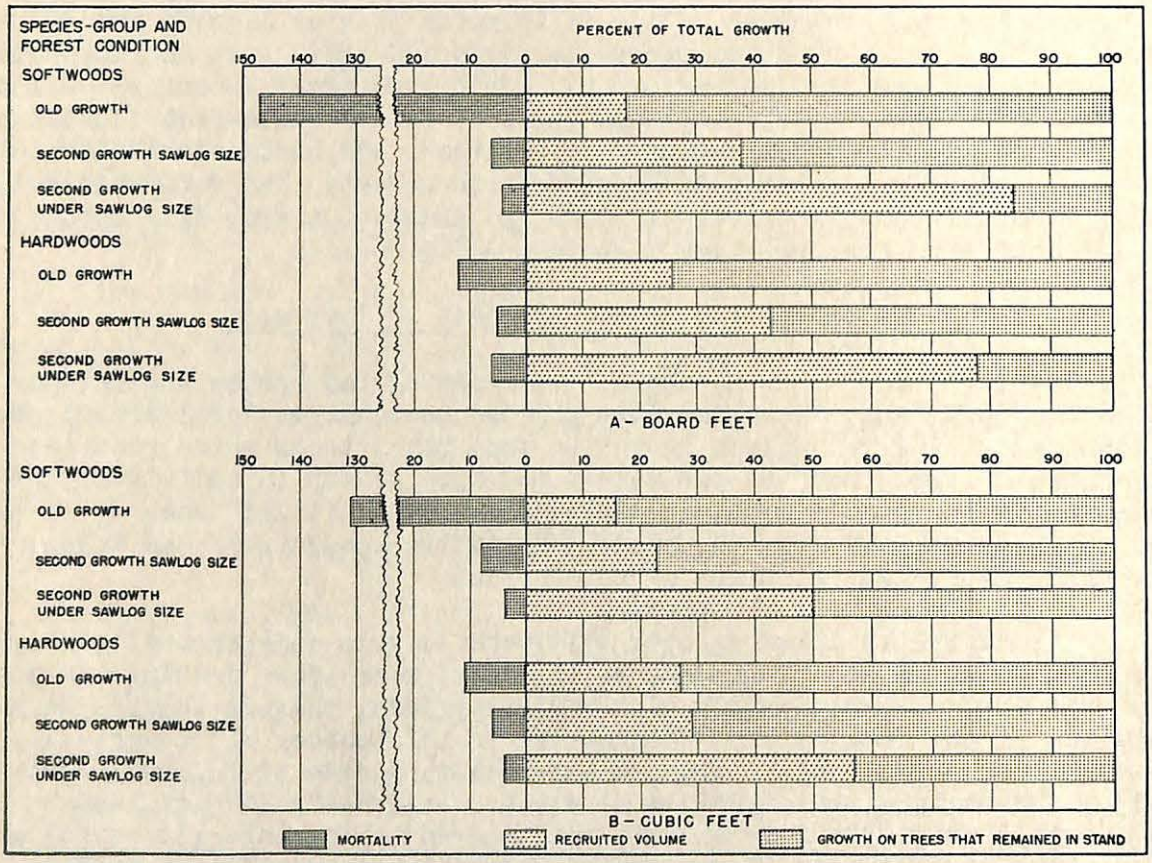
SPECIES-GROUP AND FOREST CONDITION
PERCENT OF TOTAL GROWTH
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90 100
SOFTWOODS
OLD GROWTH
SECOND GROWTH SAWLOG SIZE
SECOND GROWTH UNDER SAWLOG SIZE
HARDWOODS
OLD GROWTH
SECOND GROWTH SAWLOG SIZE
SECOND GROWTH UNDER SAWLOG SIZE
A - BOARD FEET
B - CUBIC FEET
MORTALITY
RECRUITED VOLUME
GROWTH ON TREES THAT REMAINED IN STAND

FIGURE 9.- PROPORTIONAL DISTRIBUTION OF THE ELEMENTS OF NET INCREMENT, 1938.

Increment of the Total Stand

The total growth of the forest stand in 1938 was 281 million board feet and the total mortality loss was almost 29 million board feet, leaving a net increment of over 252 million feet (table 16). About 60 percent of the increment was hardwood and 40 percent softwood. The old-growth hardwood stands increased through growth by 25 million feet but heavy mortality of old-growth hemlock caused a growing-stock reduction of nearly 4 million board feet in the old-growth softwoods. Eight percent of the net board-foot increment accrued in old-growth stands, 63 percent in second-growth sawlog-size stands, and 29 percent in stands under sawlog size. The increment of all sound trees 5.0 inches d.b.h. and larger amounted to 93 million cubic feet.

Table 16. - Net increment in board feet and cubic feet in the various forest conditions, 1938

Forest condition	Saw-timber material			All sound trees		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
	- Thousand board feet -			Thousand cubic feet (i.b.)		
Sawlog size:						
Old growth	-3,800	25,200	21,400	-540	6,900	6,360
Second growth	75,800	82,800	158,600	18,080	23,800	41,880
Under sawlog size:						
Second growth	33,100	39,300	72,400	13,600	30,680	44,280
Reproduction	Negl.	200	200	10	90	100
Total all conditions	105,100	147,500	252,600	31,150	61,470	92,620

The volume of growth, mortality, and increment in each forest condition is expressed in cords in table 17. In the softwoods the total growth was reduced 12 percent by mortality and in the hardwoods only 5 percent. The total volume lost because of mortality amounted to 115,500 cords. Almost one-fourth of this loss could have been saved if the hemlock had been utilized when the old-growth stands were cut over. About one-half of the total increment was produced in the under-sawlog-size stands which occupy 53 percent of the forest land.

Table 17. - Growth, mortality, and increment in cords in the various forest conditions, 1938

Forest condition	Softwoods			Hardwoods		
	Growth	Mortality	Increment	Growth	Mortality	Increment
	- - - - - - - - - - - - - - Cords - - - - - - - - - - - - - -					
Sawlog size:						
Old growth	22,600	29,600	-7,000	121,200	13,200	108,000
Second growth	274,600	21,200	253,400	405,600	24,100	381,500
Under sawlog size:						
Second growth	203,400	7,800	195,600	525,900	19,400	506,500
Reproduction	300	100	200	1,400	100	1,300
Total all conditions	500,900	58,700	442,200	1,054,100	56,800	997,300

Increment per Acre

The average annual increment per acre varies noticeably by forest type and condition. In table 18 the calculated full year's growth of the trees utilized is included, therefore the values are representative of increment on stands undisturbed throughout the year.

The most outstanding fact brought out by this table is the low average board-foot increment per acre, 72 board feet compared to 163 in the North Carolina Northern Coastal Plain and 149 board feet in the Piedmont. The cove hardwoods and the pine-hardwoods types are reasonably productive but the increment of the upland hardwoods type, which occupies 60 percent of the forest land, was only 91 board feet in its most productive forest condition. This low increment is partly a result of poor sites and slow growth rates but a more important contributing factor is the small volume of growing stock per acre in the upland hardwood type, averaging only 2,150 board feet in the saw-timber conditions, exclusive of dead chestnut.

In their present under-stocked condition the upland hardwood forests offer the private timberland owner little incentive to practice forestry. Even with an average stumpage price of $5.00 per thousand for all species the present increment in the most rapidly growing stands is worth less than 50 cents per acre per year. In many cases, however, the income can be gradually increased if the land-owners are able and willing to forego immediate income. Increment can be increased both in quality and quantity if the low-grade material now making up such a high proportion of the growing stock is removed and if the annual cut of good trees is restricted to less than the annual increment until a heavier stand per acre is developed. Farm operators are in an advantageous position to improve their farm woodlands because they can use such large quantities of cull material for fuelwood and fencing.

Table 18. - Average increment per acre classified according to forest condition and forest type, 1939

Forest condition	Saw-timber material						All sound trees in all types	
	Upland hdwds.	Cove hdwds.	Short-leaf pine-hdwds.	White pine hdwds.	Virginia pine-hdwds.	Average of all types	Including bark	Excluding bark
	Board feet						Cords	Cu.ft.
Sawlog size:								
Old growth:								
Uncut	73	147	16	44	--	71	.26	17.4
Partly cut	65	78	-28	-79	--	47	.25	16.2
Second growth:								
Uncut	91	206	163	198	140	136	.52	35.1
Partly cut	75	125	128	162	136	104	.44	29.2
Under sawlog size:								
Second growth	34	54	61	69	58	42	.42	26.7
Reproduction	1	3	--	--	--	1	.01	.4
Weighted average	52	101	105	117	79	72	.41	26.9

PRIMARY FOREST INDUSTRIES

Although badly depleted, the forests of the mountain region provide raw material for over 600 wood-processing plants. Sawmills are most numerous but 35 plants manufacture dimension stock, shuttle blocks, veneer, pulp and paper, excelsior, cooperage, or tanning extract. A large quantity of fuelwood is cut each year, and some crossties and poles.

The Lumber Industry

The following description of the lumber industry is based upon data obtained by a mill-to-mill canvass in 1937. In 1938 there was an 11 percent decrease in the number of mills and a 22 percent decrease in lumber production but the general character of the industry did not change. In 1937 about 642 sawmills were operating in the unit (table 19). Over 600 of these were small mills with a cutting capacity of less than 10,000 board feet per day and the rest had capacities of less than 40,000 board feet. The mills were distributed throughout the unit but were most abundant in the counties lying northeast of the French Broad River (fig. 10). Their total cut amounted to 247 million board feet: 57 percent hardwoods, 23 percent softwoods, and 20 percent sound dead chestnut.

Table 19. - Descriptive summary of lumber production in sawmills of various size-classes, 1937

Item	Capacity in thousand board feet per 10-hour day			All mills
	1 - 9	10 - 19	20 - 39	
Number of sawmills, 1937	601	30	11	642
Avg. production per mill (M bd.ft.)	264	1,283	4,536	385
Total production (M bd.ft.)	158,600	38,500	49,900	247,000
Percent production sold rough	80	75	55	75
Avg. number of employees in sawmill	4	13	36	5
Man-hours to produce 1,000 board feet:				
In woods	10	20	20	13
In sawmill	11	13	13	12
Percent of mills using:*				
Circular saws	100	85	20	95
Band saws	Negl.	15	80	5
Edgers	40	100	100	45
Planers	5	25	25	5
Dry kilns	0	5	25	Negl.

*To the nearest five percent.

Mills of 1-9 M capacity: The 601 small sawmills operating in the unit in 1937 (table 19) produced 64 percent of all lumber. By species-groups they cut 30 percent softwoods, 20 percent chestnut, and 50 percent hardwoods. They cut a much higher proportion of pine than the larger mills, producing four-fifths of all the pine lumber manufactured in the mountain region. About 75 percent of the softwood and 40 percent of the hardwood lumber was sawed from second-growth timber.

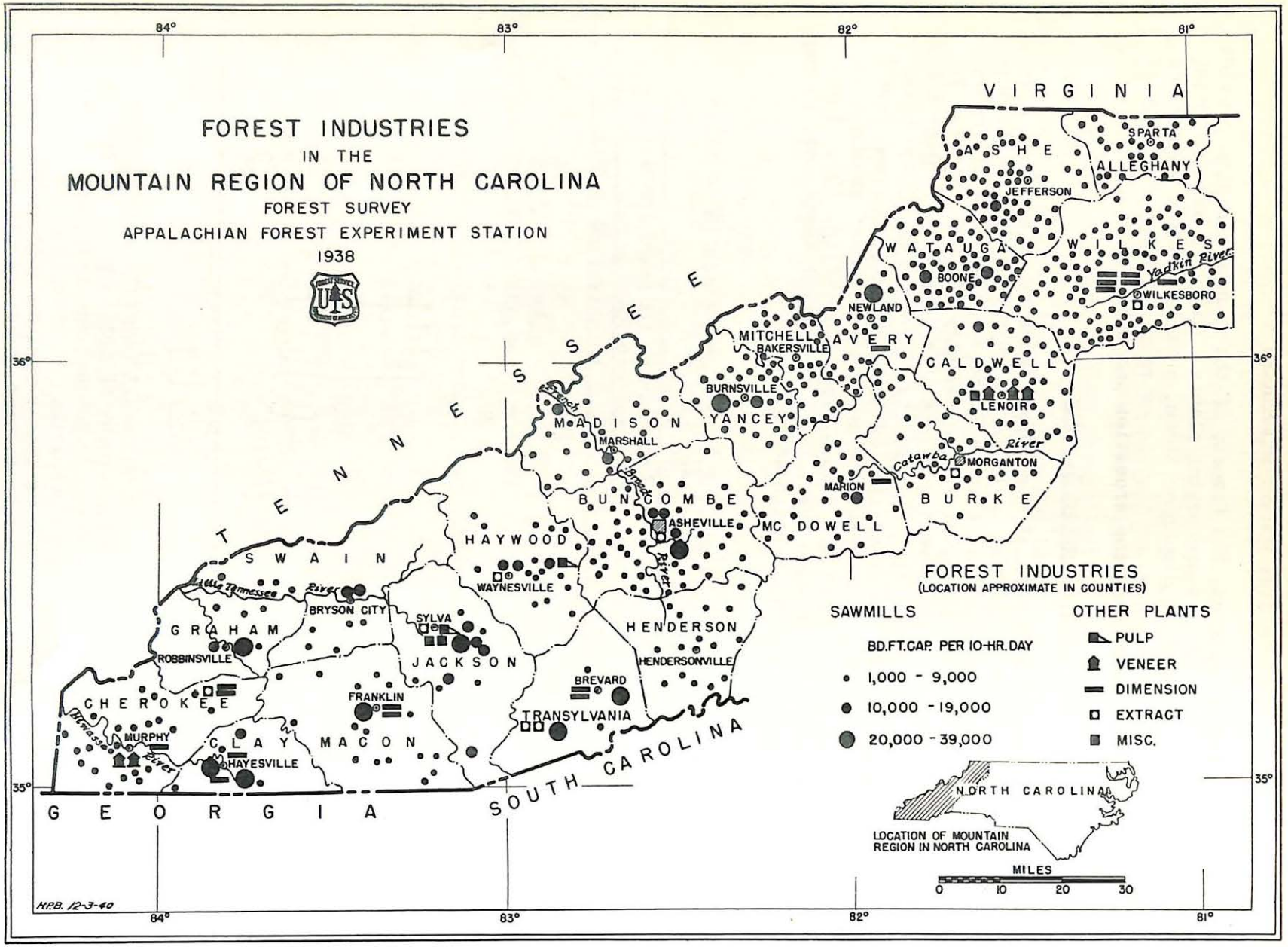
FOREST INDUSTRIES
IN THE
MOUNTAIN REGION OF NORTH CAROLINA
FOREST SURVEY
APPALACHIAN FOREST EXPERIMENT STATION
1938
VIRGINIA
TENNESSEE
GEORGIA
SOUTH CAROLINA
ASHE
SPARTA
ALLEGHANY
JEFFERSON
WATAUGA
BOONE
WILKES
Yadkin River
WILKESBORO
NEWLAND
MITCHELL
BAKERSVILLE
AVERY
CALDWELL
LENOIR
BURNSVILLE
YANCEY
MADISON
French Broad River
MARSHALL
Catawba River
MORGANTON
BUNCOMBE
ASHEVILLE
MARION
MC DOWELL
BURKE
HAYWOOD
WAYNESVILLE
SWAIN
Little Tennessee River
BRYSON CITY
GRAHAM
ROBBINSVILLE
SYLVA
JACKSON
HENDERSON
HENDERSONVILLE
CHEROKEE
FRANKLIN
BREVARD
TRANSYLVANIA
MACON
CLAY
HAYESVILLE
MURPHY
Hiwassee River
84°
83°
82°
81°
36°
35°
FOREST INDUSTRIES
(LOCATION APPROXIMATE IN COUNTIES)
SAWMILLS
BD.FT.CAP. PER 10-HR. DAY
1,000 - 9,000
10,000 - 19,000
20,000 - 39,000
OTHER PLANTS
PULP
VENEER
DIMENSION
EXTRACT
MISC.
NORTH CAROLINA
LOCATION OF MOUNTAIN REGION IN NORTH CAROLINA
MILES
0
10
20
30
H.P.B. 12-3-40

FIGURE 10

In equipment and operating organization these small mills are typical of portable mills throughout the South. Practically all of them use circular saws, less than one-half have edgers, and only a few have planers. About one-half are powered by gasoline or diesel motors, 45 percent by steam engines, 3 percent by water, and a few by electricity. On the average, 4 men are employed at each mill with 4 more in the woods cutting and hauling timber. Logging is done with teams and most of the logs are skidded directly to the mill. It is customary for these small mills to buy stumpage and move the mill to the timber, and 85 percent of the cut was obtained in this way. Only 3 percent of the logs were purchased delivered at the mill, while 12 percent were brought to the mill and sawed on a fee basis. About one-fourth of the mills do custom sawing and these mills are usually at a permanent location.

Mills of 10-19 M capacity: Thirty sawmills of this size were operating in 1937. They cut about 16 percent of the total lumber produced. Including chestnut, 86 percent of their cut was hardwood. Over four-fifths of the saw timber was cut from old-growth stands.

Two-thirds of these mills are semi-permanent but the rest move almost as frequently as the smaller portable mills. Only four of the mills used band saws. Steam engines are the favored source of power, although three mills used electricity, one used water, and one a motor unit. The most unusual mill encountered was a water-powered band mill in Watauga County which was complete with edger, trimmer, and log turner. The average mill employed 13 men and the number of woods workers per operation varied from 5 to 40. Logging was done with teams and the logs were skidded directly to most of the portable mills. Trucks were used for transporting logs from the woods to the semi-permanent mills. Three-fourths of the saw timber was purchased as stumpage and the remainder was bought as logs delivered at the mill yard.

Mills of 20-39 M capacity: Only 11 sawmills in the unit have a cutting capacity of 20,000 or more board feet per day. The Carr Lumber Company at Pisgah Forest and the Bemis Lumber Company at Robbinsville are the largest operators but the Gloucester Lumber Company at Rosman and the Blackwood Lumber Company at East Laporte closely approach them in quantity of lumber sawed. The 11 mills cut almost 50 million feet of lumber in 1937, about 20 percent of the total production. Over 90 percent of their cut was mixed hardwoods and chestnut and practically all of the sawlogs used were cut from old-growth timber.

All but two were band mills. Steam was the primary power in all mills. Employees per mill averaged 36, although there was a wide range among mills. Loggers varied in number from 10 to 85 per operation. Skidding was done with teams and most of the logs were brought to the mill by truck. The Bemis Lumber Company is the only one still operating a logging railroad. About 45 percent of the logs were purchased as stumpage, 35 percent were purchased delivered at the mill yard, and 20 percent were cut from lands of the operating lumber companies.

Production in 1937 and 1938: The number of operating sawmills decreased from 642 in 1937 to 570 in 1938 and the production of lumber decreased from 247 million board feet to 193 million feet, a reduction of 22

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EXPERIMENT STATION

percent (table 20). Mills of all capacities were affected but those with a cutting capacity of 10,000 to 19,000 board feet per day reduced their cut most. In 1938 the production of hardwood lumber, including chestnut, declined about one-fourth, whereas the production of softwood lumber, chiefly yellow pine, was maintained at almost the 1937 level.

Table 20. - Lumber production in 1937 and 1938, classified according to size of mill

Rated capacity (10-hr. day)	Lumber production - 1937				Lumber production - 1938*			
	Soft-wood	Chest-nut	Hard-wood	Total	Soft-wood	Chest-nut	Hard-wood	Total
M board feet	- - - M board feet - -				- - - M board feet - - -			
1 - 9	46,800	31,800	80,000	158,600	46,200	25,300	61,400	132,900
10 - 19	5,200	8,700	24,600	38,500	3,300	6,700	15,000	25,000
20 - 39	4,400	10,100	35,400	49,900	4,600	5,800	25,100	35,500
Total	56,400	50,600	140,000	247,000	54,100	37,800	101,500	193,400

*Compiled from data obtained cooperatively with the Bureau of the Census for mills which cut more than 50 M bd.ft. per year. The cut of 106 small mills which sawed less than 50 M feet is included (1,200 M bd.ft. of softwood, 500 M bd.ft. of chestnut, and 1,200 M bd.ft. of hardwood lumber).

Lumber prices: The selling price of hardwood lumber is influenced by several factors which are in turn modified by general market conditions. There is a wide range in the value of the various species, quality of saw timber affects lumber grades, manufacturing processes affect the value of the finished lumber, and different operators possess varying degrees of bargaining power. As a rule the larger, well-equipped sawmills obtain better prices for their lumber than do the smaller mills. This is evident in table 21, which shows the average prices received in 1939 for rough lumber of various species by a representative sawmill in each of the designated capacity-classes.

Table 21. - Average selling price of rough lumber at a sawmill of indicated cutting capacity, 1939

Species	Capacity in thousand board feet per 10-hour day				
	30	25	12	8	4
	- - - - - - Dollars per thousand board feet - - - - - -				
Cherry	44	35	--	--	--
Sugar maple	40	30	35	28	25
Ash	38	30	30	20	17
Yellowpoplar	37	25	25	22	18
Birch	36	30	--	25	--
Basswood	35	30	25	25	--
Oak	25	21	25	26	18
Beech	24	--	23	--	--
Buckeye	20	18	--	--	--
Chestnut	19	20	18	14	16

Other Forest Industries

In addition to sawmills there were about 35 plants using wood or bark as a primary raw material in 1938. The largest plants were the two pulp and paper mills located at Canton and Sylva. Eleven plants made hardwood dimension stock, 6 made shuttle blocks, 8 used wood or bark for making tanning extract, 5 made veneer, and one each made excelsior, insulator pins, and tight cooperage. The dimension stock mills and veneer plants used about 10 million board feet of hardwood and the remaining plants used about 320,000 cords of pine, hardwood, and dead chestnut and 20,000 tons of chestnut oak and hemlock bark.

Hardwood dimension stock: In 1938 there were two more dimension stock mills than in 1937. The 11 mills operating during 1938 used 1.8 million board feet of hardwoods and 400,000 board feet of pine. The hardwood was used for furniture stock and the pine for crating. About 30 percent of the hardwood was yellowpoplar, 25 percent was maple, 25 percent was hickory, 15 percent was white oak, and the rest was beech, birch, and walnut. Practically all of the logs were purchased delivered at the mill. Six of the mills were located near North Wilkesboro in Wilkes County. All of the mills are small and only 50 men were employed in the 11 plants.

Veneer: The consumption of hardwood by the five veneer plants decreased from 8 million board feet in 1937 to 7.3 million feet in 1938. A large proportion of the veneer was made from yellowpoplar, but basswood, maple, sweetgum, blackgum, white oak, and even hickory were used. At least three-fourths of the veneer bolts were cut from old-growth timber and all of them were purchased delivered at the plant.

Seventy-three percent of the wood used for veneer in 1938 was cut in this unit, 23 percent was brought from South Carolina, and 4 percent from Georgia. Yellowpoplar bolts trucked 70 miles from South Carolina were delivered at Lenoir for about $22.00 per thousand board feet Doyle scale although number 1 bolts brought as high as $32.50 per thousand feet and number 2 bolts as low as $12.50 per thousand.

Shuttle blocks: Although the number of shuttle block mills decreased from seven in 1937 to six in 1938 the total consumption of wood increased from 780 cords to 890 cords. Dogwood was used by all of the plants except one which used beech, birch, and maple. Plant capacities ranged from one-third to three cords per day and the average mill employed 3 workers. The wood was purchased by the cord from local farmers and a large proportion of the rough blocks were shipped to Greenville, South Carolina, and Charlotte, North Carolina, for manufacture into shuttles.

Pulpwood and extract wood: The Champion Paper and Fibre Company at Canton is the largest user of pulpwood and extract wood. It makes a diversity of products including ground wood, bleached sulphite, sulphate, and soda pulps, kraft, writing, and specialty papers, and is the largest producer of tanning extract in the United States. The Sylva Paperboard Company at Sylva is also an integrated operation making tanning extract and chestnut paperboard for corrugating. Eight other plants make tanning extract from chestnut wood and the bark of chestnut oak and hemlock. In 1938

the 10 extract plants used 170,000 cords of chestnut wood and about 20,000 cords of oak and hemlock bark.

Excelsior, insulator pins, and cooperage: In 1938 a plant at Lenoir made excelsior, one at Dillsboro made insulator pins, and a tight cooperage plant operated at Sylva. Altogether these three plants used about 1,900 cords of wood and gave employment to about 55 men. Two-thirds of the excelsior was made from pine and the rest from yellowpoplar. The peeled wood was purchased by the 144 cubic-foot unit delivered at the plant. The insulator pins were made of oak and the wood was bought in the form of split pieces measuring 18 x 1-3/4 x 1-3/4 inches. On the average six pins were obtained from each piece. The cooperage plant used white oak for the manufacture of whiskey and oil barrel staves. A cord of wood yielded about 250 staves.

Fuelwood: The estimated total consumption of fuelwood in 1938 was 787,000 cords, about 70 percent hardwoods and 30 percent pine. Three-fifths of the wood was obtained from cull trees, sawmill slabs, and tops of trees felled for other uses and the rest was obtained from the sound-tree growing stock. Farmers used 82 percent of the fuelwood, rural non-farm residents 14 percent, and urban dwellers, schools, and small commercial establishments only 4 percent. About 3,000 cords of wood were used for flue-curing tobacco in the northeastern counties of the unit. The average farm family used 14.0 cords of fuelwood, the average rural non-farm family 4.0 cords, and the average urban family only 1.5 cords.

Other products: Numerous timber products not manufactured in local plants were cut from the forests of this unit. The amount of wood cut by farmers for fence posts and farm construction was estimated to be 28,000 cords. Over 15 million board feet of sawlogs were shipped to sawmills in Tennessee and the Piedmont of North Carolina. About 1,400 cords of chestnut extract wood and 23,000 cords of hardwood pulpwood and distillation wood were also drawn from this unit by Tennessee mills. Railroads and treating plants purchased about 8,000 locust posts and 100,000 hewn hardwood crossties. Power, telephone, and railway companies bought 2,400 poles, chiefly locust and chestnut. About 300,000 board feet of veneer bolts were trucked to veneer plants in the Piedmont of North Carolina. It is apparent that the forests of this unit can supply a great variety of raw material for wood-using industries. There is need, however, for developing new industries to use low-quality species and sound material in cull trees.

Employment and Income

In 1938 the primary wood-using industries including fuelwood, provided about 2.3 million man-days of employment, equivalent to 9,340 man-years of 250 days each (table 22). The 605 forest products plants employed about 6,600 men, many of whom worked part-time, and furnished one-third of the total man-days of employment. About 3,000 men worked in sawmills, 2,700 worked in pulpmills, 600 in extract plants, 200 in veneer plants, and the remainder in dimension, shuttle block, cooperage, excelsior, and insulator pin mills. At 25 cents an hour the mill workers received about 1.9 million dollars in wages or $285 per worker per year.

Two-thirds of the total employment was utilized in cutting fuelwood, crossties, poles, and raw material for the wood-using plants. Preparing fuelwood and other material for domestic use called for the expenditure of nearly one million man-days of labor, three-fifths of all the woods employment. Only 609,000 man-days were spent in cutting sawlogs, bolts, crossties, poles, pulpwood, and extract wood for a cash income. The total number of men who obtained part or all of their income from industrial woods work is unknown, but if each worker were occupied 250 days per year only 2,440 individuals would have been employed. It is probable that most workers averaged around 100 days per year in which case about 6,000 men worked in the woods. Their income was about 1.5 million dollars in 1938.

Table 22. - Production and employment in the primary forest industries, 1938

Commodity	Number of plants	Material cut in woods	Produced or used by plants	Employment provided		
				In woods	In plants	Total
		- M board feet -		- M man-days of 10 hours -		
Lumber	570	204,300	193,400	265	225	490
Veneer	5	5,600	7,300	15	41	56
Hardwood dimension	11	2,200	2,200	4	6	10
		M pieces				
Hewn crossties	--	102	--	14	--	14
Poles and posts	--	11	--	1	--	1
		M cords				
Fuelwood	--	787	--	944	--	944
Misc. farm wood	--	28	--	31	--	31
Shuttle blocks	6	1	1	3	3	6
Extract and pulpwood*	10	268	336	304	470	774
Misc. mfg. products**	3	2	2	3	5	8
Total	605	--	--	1,584	750	2,334

*Includes both wood and bark.

**One cooperage plant, one excelsior plant, and one insulator pin plant.

COMMODITY DRAIN

The commodity drain from the sound-tree growing stock includes both the material utilized and the sound usable material left in felled trees. The drain on the saw-timber portion of the trees, including both the utilized and wasted portions, is expressed in board feet, whereas the volumes given in cubic feet and cords include drain on saw-timber material, upper stems of sawlog-size softwoods, and small trees ranging from 5.0 inches d.b.h. to sawlog size. The drain on hardwood tops and on dead chestnut is not included.

The drain upon saw-timber material in 1938 amounted to 98 million board feet of softwoods and 155 million feet of hardwoods (table 23). Forest industries and domestic consumers within the unit used about 89 million board feet of softwoods and 9 million feet were taken to sawmills in the Piedmont of North Carolina. About 145 million feet of the hardwood drain were used within the unit and 10 million feet were sold to sawmills and veneer plants in the North Carolina Piedmont and to sawmills and pulpmills in Tennessee. The movement of rough wood into the unit exceeded the shipments to other areas by three million board feet.

The total drain upon the sound-tree growing stock 5.0 inches d.b.h. and larger was 66 million cubic feet, 62 percent hardwoods and 38 percent softwoods. About 72 percent of the hardwood and 86 percent of the softwood cubic-foot drain was obtained from saw-timber trees. The greatest use of under-sawlog-size trees of both species-groups was for fuelwood, although 1.3 million cubic feet of small hardwoods were cut for pulpwood. Lumber, fuelwood, and pulpwood accounted for over nine-tenths of the total cubic-foot drain.

Table 23. - Commodity drain from the sound-tree growing stock, 1938

Commodity	Saw-timber material			All sound trees*		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
	Thousand board feet			Thousand cubic feet		
Lumber	63,900	111,000	174,900	13,800	20,740	34,540
Veneer	--	5,900	5,900	--	1,100	1,100
Dimension stock	400	1,900	2,300	90	360	450
Shuttle blocks	--	--	--	--	60	60
Pulpwood	15,000	3,800	18,800	3,950	2,110	6,060
Poles and posts	--	--	--	--	40	40
Crossties	200	6,400	6,600	40	1,210	1,250
Fuelwood	17,000	23,700	40,700	6,340	14,430	20,770
Misc. farm use	900	1,800	2,700	550	910	1,460
Misc. mfg. products	300	300	600	80	50	130
Total	97,700	154,800	252,500	24,850	41,010	65,860

*Total drain from growing stock expressed in cords of wood with bark: 343,500 cords of softwoods, 632,100 cords of hardwoods.

COMPARISON OF INCREMENT WITH COMMODITY DRAIN

The commodity drain upon a forest represents the contribution of the resource to industry, employment, and domestic needs. Those benefits generally increase in proportion to the volume of wood utilized. For permanent benefits, the forest must yield enough wood each year, on the average, to compensate for the annual drain. Also, when the forests are badly depleted, as are those of the mountain region, the increment should be greater than the drain so that the growing stock can have an opportunity to increase and fully occupy the forest land. As in other crops, partial stands yield only partial harvests.

Comparison in Board Feet

The over-all effect of utilization upon the board-foot growing stock is indicated in table 24. The net increment of the softwood stand exceeded the drain by seven million board feet, a relatively insignificant surplus as it increased the growing stock by less than one percent. Although the stand increased slightly the cut was made at the expense of the better-quality material. In the old-growth softwoods the drain amounted to 27 million board feet while the total growth was only 8 million feet. Further reductions were caused by mortality and altogether the old-growth stands decreased by 31 million feet. In the second-growth stands increment exceeded drain by a considerable margin, especially in the under-sawlog-size stands where the board-foot drain was minor and the saw-timber volume recruited from young trees amounted to more than 29 million board feet.

Table 24. - Comparison between increment and drain of saw-timber material, 1938

Item	Softwoods	Hardwoods	Total
	- - - Thousand board feet - - -		
Net growing stock, January 1, 1938	2,080,000	3,029,900	5,109,900
Growth, 1938	123,500	157,800	281,300
Mortality, 1938	18,400	10,300	28,700
Net increment, 1938	105,100	147,500	252,600
Commodity drain, 1938	97,700	154,800	252,500
Net change in growing stock, 1938	+7,400	-7,300	+100
Net growing stock, December 31, 1938	2,087,400	3,022,600	5,110,000

In the hardwoods, increment failed to equal commodity drain. The high-quality old-growth saw timber is being cut about three times as fast as it is growing and before many years the old-growth timber in private ownership will be exhausted. When it is, most of the band mills within this

unit will be forced to close down unless they can obtain enough timber from the National Forests and outside sources. The second-growth saw-timber stands cannot, in their present condition, be relied upon to support a greater cut because drain already almost equals increment. The future of the hardwood industry lies in the under-sawlog-size stands which occupy such a large part of the forest area. These stands were increasing at the rate of 34 million board feet per year in 1938, but in general it will be several decades before they produce operable saw timber.

Comparison in Cubic Feet

The influence of the large volume of young, under-sawlog-size hardwood growing stock is apparent in the cubic-foot comparison of increment and drain given in table 25. In contrast with the hardwood saw-timber stands, which are decreasing, the total stand of this class increased nearly two percent.

Table 25. - Comparison between increment and drain of all sound material, 1938

Item	Softwoods	Hardwoods	Total
	Thousand cubic feet (i.b.)		
Net growing stock, January 1, 1938	632,730	1,136,110	1,768,840
Growth, 1938	35,480	65,080	100,560
Mortality, 1938	4,330	3,610	7,940
Net increment, 1938	31,150	61,470	92,620
Commodity drain, 1938	24,850	41,010	65,860
Net change in growing stock, 1938	+6,300	+20,460	+26,760
Net growing stock, December 31, 1938	639,030	1,156,570	1,795,600

The net change in growing stock shown in table 25 has been separated into its constituent parts in table 26 to show in which forest conditions and diameter-groups the losses and gains occurred. In the softwoods there was a loss in volume in old-growth saw-timber trees and also in the small trees of the second-growth sawlog-size stands. The old-growth hardwoods of saw-timber size are decreasing and not now being replaced even in quantity by second-growth timber. As time passes, however, the saw-timber growing stock will be greatly augmented by the small trees at present in under-sawlog-size stands.

Table 26. - Change in growing stock by forest conditions and diameter-groups, 1938

Forest condition	Softwoods			Hardwoods		
	5.0 - 8.9 inches d.b.h.	9.0 inches d.b.h. and larger	Total	5.0 - 12.9 inches d.b.h.	13.0 inches d.b.h. and larger	Total
	- - M cu.ft. (i.b.) - -			- - M cu.ft. (i.b.) - -		
Old growth	90	-6,510	-6,420	2,130	-9,180	-7,050
Second growth:						
Sawlog size	-780	3,100	2,320	1,740	1,680	3,420
Under sawlog size	4,420	5,980	10,400	17,890	6,200	24,090
Total all conditions	3,730	2,570	6,300	21,760	-1,300	20,460

Comparison in Cords

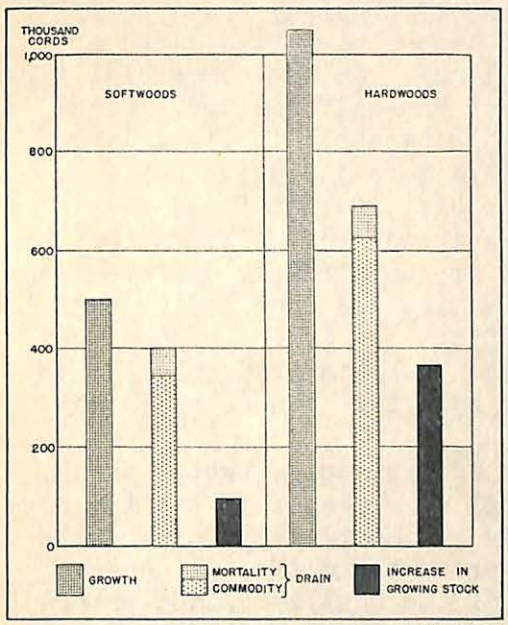

FIGURE 11-COMPARISON OF GROWTH WITH MORTALITY AND COMMODITY DRAIN, 1938.

The relation of total growth to mortality and commodity drain and the resulting change in growing stock are presented in cords in figure 11 which shows that the total increase in stand volume amounted to 99,000 cords of softwoods and 365,000 cords of hardwoods. There was not, however, an increase in all forest conditions. In the old-growth stands there was a decrease of about 88,000 cords in the softwood volume and about 101,000 cords in the hardwood volume. There was a small increase in the second-growth sawlog-size stands amounting to about 36,000 cords of softwoods and 66,000 cords of hardwoods but the most striking increase occurred in the under-sawlog-size stands where the softwoods increased by 151,000 cords and the hardwoods by 400,000 cords. The above figures indicate that both the old-growth and second-growth saw-timber stands are being overcut, and although not apparent in these totals, the cutting is generally in the larger, better-quality timber while the bulk of the increment is in the younger, smaller, and less valuable trees. At present, therefore, the saw-timber stands are decreasing both in quantity and quality but the excess of increment over drain in the under-sawlog-size stand augurs well for the long-time future of the forest resource if over-cutting can be avoided during the years in which these young stands are growing to maturity. It is true that some of the trees in these young stands are of inferior species, some have been injured by fire, and many are defective because of rot. In general, however, these young stands will develop into a satisfactory source of saw timber, given fire protection, a reasonable amount of cultural treatment, and protection from premature cutting. It is encouraging to find that on some cutover areas the proportion of desirable species such as yellowpoplar is greater than in the original stands.

THE FORESTS AND ECONOMIC IMPROVEMENT

Within the mountain region of North Carolina many social, economic, and industrial problems are related directly or indirectly to the forest resource. Because of the complexity of our modern life there is no clear-cut dividing line between these problems but in the aggregate they present a maladjustment between population and opportunity for income.

There are several reasons for this situation. Primarily, there is a very high birth rate -- 50 percent above the average for the nation. Among the rural people there are close family ties and migration to other regions is largely by the more progressive individuals, who can be spared least from their communities. The time honored custom of dividing the family farm among the children has resulted in a great number of farms too small to adequately support a family. Topography and soil place rather definite limits upon the amount of land that can be used for cultivated crops and the efforts to arbitrarily exceed these limits have caused extensive depletion of the soil resource.

The forest resource has likewise been badly treated. Because of their pressing need for income the small land-owners have liquidated a large part of the timber values in their woodlands. On the commercial forest land logging has been in progress for about one-half century. Constantly decreasing quality standards have made it possible to log a large part of the area several times, each time with a more inclusive cut and with less growing stock left standing. In the past, forest fires were common and the effects are seen in many fire-scarred, rotten stems that are a liability in the growing stock. Conditions are not greatly different on most of the publicly owned land, because the damage was done before the title was acquired by public agencies. In effect, the forest of the region has been so heavily cut, culled and burned that its productivity has been greatly reduced. Many years will elapse before it can be restored.

In a realistic approach to the problem of developing better social and economic conditions in this region, it must be recognized that the forest, as a timber-producing resource, will play a comparatively minor role for at least several decades. Even with its present limitations, however, the forest is a necessary adjunct to several of the most important enterprises in the region. Most conspicuous is the part the forest plays in the support of the tourist and recreation industry. The beautiful wooded mountains with their flowering shrubs, clear trout streams, and wild game have a definite cash value to the local people. Many towns and rural homes obtain a large part of their income through the sale of food, lodging, farm produce, and mountain handicraft to visitors who come to enjoy the recreational advantages.

The topography and rainfall are conducive to the development of hydro-electric power. The forest serves in the regulation of stream flow and the prevention of erosion on the watersheds of developed streams. In addition to influencing power development, the forest watersheds of the region are a direct source of water for several of the largest industrial plants. The value of the forest in relation to hydro-electric power and industrial water supply may exceed its value as a potential producer of raw material for industry.

While the benefit of a greater timber supply should not be underestimated it seems probable that the most immediate improvement in the standard of living can be obtained through the establishment of more large manufacturing plants that would draw raw material from other regions. A recently established example is the cigarette-paper plant of the Ecusta Paper Corporation which obtains water from the Pisgah National Forest and flax from Minnesota, California, and North Dakota. As originally constructed this plant employed almost 1,000 workmen but when proposed expansions are completed a much larger number will be needed.

The beneficial effect of such plants upon employment and income opportunities are obvious, but sound planning of regional development on a long-time basis cannot afford to neglect the local natural resources that use local labor in both their production and manufacture. It is important to remember that the mountain forests can be used for timber production without seriously interfering with their functions of recreation, stream control, and water supply.

At present the yield of merchantable wood from the forest is small because of the large area stocked with small timber, the high proportion of cull volume in the stand, and the small amount of growing stock per acre. Increasing the yield is primarily a matter of time and fire protection, for about one-half of the area supports trees that must grow from a few years to several decades before they reach saw-timber size. During this time, they and the existing saw-timber stands should receive the intensive fire protection now accorded most of the forest area by the State and Federal fire protection organizations. The forest growing stock would also develop faster if the annual cut were reduced for the next decade but in this respect the immediate needs of the people and industries must be balanced against the needs of the forest. Even without a reduction in cut it is possible to improve the growing stock. On some favorably located operations a greater proportion of the cut can be obtained from thinnings and improvement cuttings in those species which can be handled without loss. In certain localities the utilization of sound, dead chestnut instead of small growing saw timber might afford the needed income for a few years. The conservative use of portable sawmills would facilitate the removal of low-grade material on many areas inoperable for band mills. Farmers, who own almost one-half the forest land, can improve their woodlands by utilizing more cull trees for fuelwood. Developing new plants to use hardwood pieces in short lengths and small diameters would also provide a market for some of the low-grade wood now considered cull material. In brief, there should be a constant effort to improve and protect the forest while the young stands are developing. At the same time the wood-using industries should follow a policy of conservative cutting to prevent further depletion of the saw-timber growing stock. When put into practice by farmers, commercial operators, and public agencies these measures will help to develop a greater and more valuable forest resource, capable of making a permanent and significant contribution to the social and economic welfare of the mountain people.

REVIEW OF THE REPORT

In the rugged mountain region of Western North Carolina the opportunities for obtaining an adequate income are limited. A majority of the people are engaged in agriculture, but because of population density and topographical limitations many of the farms are too small to provide a comfortable living. Although large industrial plants are operating in several counties, only one-fifth of all the people employed are engaged in manufacturing. The tourist trade is an important source of income throughout the region. About 600 primary wood-using plants utilize the timber resource.

Exclusive of the Great Smoky Mountains National Park, forests occupy 3.6 million acres, two-thirds of the land in the region. As a group, oak species predominate but sound dead chestnut and shortleaf pine are the two most abundant species. Hardwood types occupy 70 percent of the forest land and pine types 30 percent. Almost 90 percent of the land supports second-growth timber and 53 percent of the total forest area is stocked with under-sawlog-size stands. Nine-tenths of the forest land is in a fair to good timber-growing site.

The total saw-timber volume is nearly six billion board feet, about one-third softwoods and two-thirds hardwoods. Including usable chestnut there are about 50 million standard cords of all sound wood with bark. Excluding chestnut and the bark of all species, there are 2.6 billion cubic feet of wood.

Increment amounted to 253 million board feet, 1.4 million cords, or 93 million cubic feet. The average annual increment per acre was only 72 board feet of saw timber, or four-tenths of a cord of all sound material.

About 600 primary forest products plants operated in the mountain region in 1938. A variety of plants were represented, including 570 sawmills, 11 dimension stock mills, 8 extract plants, 6 shuttle block mills, 5 veneer plants, 2 pulp mills, and other plants making cooperage, excelsior, and insulator pins. The sawmills produced 247 million board feet of lumber in 1937 and 193 million board feet in 1938. About 787,000 cords of fuelwood were cut. In both woods and mills the forest resource provided 2.3 million man-days of employment to about 12,000 workmen.

The total commodity drain upon the forest was 252 million board feet of saw timber or 66 million cubic feet of all sound material. The softwood growing stock increased by seven million board feet in 1938 and the hardwood decreased by the same amount. The total stand increased by 27 million cubic feet, equivalent to 464,000 cords.

The forest resource is so depleted that yields of wood will remain low for many years. Consequently there is little opportunity for any immediate expansion in the wood-using industries and it is probable that some of the larger sawmills will soon cease operating. The relation of the forest to recreation, stream control, and water supply is important, but the mountain forests can be used for these functions without interfering with their use for timber production. In the next few decades the yield of timber can be greatly increased if there is a constant effort to improve and protect the young timber while it is developing and a conservative cutting policy is practiced in the saw-timber stands.

GLOSSARY

General

Forest Survey Unit. -- The term "forest survey unit" denotes an area of 4 to 10 million acres in which topographic, forest, economic, and industrial conditions are reasonably homogeneous.

Land-use Classes

Productive forest area. -- Forest land having qualities essential for the growth of commercial timber.

Nonproductive forest area. -- Forest land lacking qualities essential for the growth of commercial timber.

Cropland, old and new. -- Land used for production of farm or orchard crops or evidently so used during the past 5 years. This includes new cropland, i.e., land converted from forest to cropland within 5 years prior to survey.

Pasture. -- Cleared or open land under fence used primarily for grazing.

Abandoned cropland. -- Land once cultivated but showing distinct evidence of having been abandoned for agricultural crop production.

Other non-forest. -- Areas included within the corporate limits and surburban or industrial sections of cities and communities; power, rail, and highway rights-of-way; marsh; and nonmeandered waterways.

Forest Types

Upland hardwoods. -- Stands in which mixed oaks, chestnut, and other hardwoods make up 75 percent or more of the dominant and codominant stems found throughout the mountain region.

Cove hardwoods. -- Stands in which yellowpoplar, cucumber, red maple, white ash, black birch, buckeye, and basswood make up 75 percent or more of the dominant and codominant stems, usually found on lower north slopes and in coves along small streams.

Shortleaf pine-hardwoods. -- Stands in which pines make up 25 percent or more of the dominant and codominant stems with shortleaf pine predominating. Includes stands of table mountain and pitch pine.

White pine-hardwoods. -- Stands in which pines make up 25 percent or more of the dominant and codominant stems with white pine predominating. Includes stands of hemlock, red spruce, and Fraser fir.

Virginia pine-hardwoods. -- Stands in which pines make up 25 percent or more of the dominant and codominant stems with Virginia pine predominating.

Diameters

D.b.h. (diameter at breast height). -- Diameter, outside of bark, measured at 4½ feet from the ground.

Diameter class. -- All trees were recorded in 2-inch diameter classes, including diameters 1.0 inch below and 0.9 above the stated midpoint, e.g., trees 7.0 to 8.9 inches d.b.h. are placed in the 8-inch class.

Tree Classification

Sound sawlog-size tree. -- A pine tree at least 9.0 inches d.b.h., a yellowpoplar, basswood, ash, cherry, or walnut tree at least 11.0 inches d.b.h. and other hardwood trees at least 13.0 inches d.b.h., with not less than one sound butt log 12 feet long, or with 50 percent of the gross volume of the tree in sound saw timber.

Sound under-sawlog-size tree. -- Any tree over 1.0 inch d.b.h. and less than sawlog-size, with a reasonably straight sound stem.

Cull tree. -- Any tree that fails to qualify as a sound sawlog or under-sawlog-size tree because of form, limbiness, rot, or other defect.

Forest Conditions

Sawlog Size

Old growth, uncut. -- Stands composed of trees having the characteristics of the original mature timber of the region and containing at least 1,000 board feet per acre of merchantable species in hardwood types, and 600 board feet per acre in pine types, with less than 10 percent of the volume cut.

Old growth, partly cut. -- Old-growth stands from which 10 percent or more of the volume has been cut, leaving a minimum of 1,000 board feet per acre in the hardwood types, or 600 board feet per acre in the pine types.

Second growth, uncut. -- Stands of second growth having at least 600 board feet per acre in trees of sawlog-size, and with less than 10 percent of the sawlog-size trees removed.

Second growth, partly cut. -- Stands of second growth from which 10 percent or more of the sawlog-size trees have been removed but with the remaining stand containing 600 or more board feet per acre.

Under Sawlog Size

Second growth. -- Young second-growth stands in which the volume of timber in trees of sawlog size is less than 600 board feet per acre and the remainder of the trees are below sawlog size.

Reproduction. -- Stands too young to classify as second growth having at least 80 well distributed seedlings per acre.

Clear-cut. -- Cut-over areas having insufficient young growth to qualify either as second growth or reproduction.

Volume Estimates

Board-foot volume. -- Only the saw-timber portion of sawlog-size trees are included in this estimate. Top diameters vary with the limits of usable material. Deductions are made for woods cull and for loss in sawing at the mill.

Cordwood volume. -- This volume (including bark) is derived from the following sources:

1. The sawlog portion of sawlog-size trees.

2. The portion of saw-timber trees not usable as sawlogs but acceptable as cordwood. This includes the upper stems of pine and cedar and, unless otherwise noted, the upper stems and limbs of hardwoods. The minimum diameter limit is 4.0 inches outside bark.

3. The full stem of sound under-sawlog-size trees, at least 5.0 inches d.b.h., to a variable top diameter not less than 4.0 inches outside bark.

4. The estimated sound material in cull trees.

Deductions for cull include only the volume in defects which cause the material to be unsuited for cordwood. Sweep and slight crook are not regarded as defects.

Cubic-foot volume. -- This volume is derived from the same sources as the cordwood volume except that bark is not included.

Standard cord. -- A stacked pile of round or split wood bolts measuring 4' x 4' x 8' and estimated to contain 90 cubic feet of wood and bark in the pine and cedar species, and 80 cubic feet of wood and bark in the hardwood species.

Increment

Growing stock. -- The sum of the volumes of all sound trees 5.0 inches d.b.h. and larger; dead and cull trees and tops of hardwood not included.

Board-foot increment. -- Includes the net growth on the saw-timber portion of sawlog-size trees, plus the volume in sound trees reaching sawlog-size.

Cordwood increment. -- Includes the net growth on the sound stemwood of pines and cedar 5.0 inches d.b.h. and over, on under sawlog-size hardwoods, and on the sawlog portion of sawlog-size hardwoods, plus the sound-tree volume of all species reaching 5.0 inches d.b.h. during the increment period.

Cubic-foot increment. -- Omits bark volumes, otherwise material is identical with cordwood.

Mortality

Mortality. -- The volume lost from the growing stock of the forest through the death of individual trees. Natural causes of mortality include lightning, tree competition, old age, disease, insects, drought, and wind. Fire is the major man-caused source of mortality.

Site Quality

Good site. -- Land representing the best growing conditions in the region usually located in coves, along streams, and on the lower north and east slopes. Stands composed of desirable species of good form. Mature dominant yellowpoplar trees on this site will average four or more 16-foot logs per tree, other hardwoods three or more logs, shortleaf pine four or more logs, and white pine and hemlock five or more.

Fair site. -- Land representing average growing conditions in the region, usually found on the lower south and west slopes and upper north and east slopes. Mature dominant yellowpoplar trees on this site will average two to four 16-foot logs per tree, other hardwoods one and one-half to three logs, shortleaf pine two to four logs, and white pine and hemlock three to five logs.

Poor site. -- Land representing below average growing conditions usually located on upper south and west slopes and dry ridge tops where soil depth and moisture are deficient. Rock outcrops are frequent and the soil contains numerous rock fragments. This site excludes land incapable of growing commercial timber, which is classified as nonproductive forest land (table 2). Mature hardwood trees will average about one 16-foot log per tree, shortleaf pine less than two logs and white pine and hemlock less than three logs.

Hardwood Log Grades

Hardwood Log Grades - Applicable to yellowpoplar, basswood, maple, black cherry, ash, northern red oak, white oak, chestnut oak, red oaks, birch, beech, hickory.

Log grade	Minimum length of log	Minimum diameter at small end of log	Allowable proportion of gross scale in defects*	Surface requirements		
				Proportion of 3 visible faces that must be clear	Allowable number of cuttings	Minimum length of cuttings
	Feet	Inches	Percent	Percent	Number	Feet
No. 1 (butt logs)	10	12**	25	80	1	8
No. 1	10	16	40	80	2	5
No. 2	8	12	40	66	2	4
No. 2	12	10	40	66	3	4
No. 3	10	8	40	50	No. limit	3
No. 3	10	11	50	40	No. limit	3

*If the total permissible defect is represented by sweep, the log should be degraded one grade. Mineral stain or blackheart permissible in not over one-half of the diameter. More than this will degrade the log. If the blackheart or mineral stain will not produce high grade No. 3 common lumber, it should be scaled out.

**Applies to sugar maple, basswood, cherry, ash, and northern red oak, all other hardwoods must be two inches larger to qualify as No. 1 logs. Worm holes not permitted in any No. 1 logs.